ANON

1943

The Maine Agricultural Experiment Station

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Potato seedlings or new unnamed varieties exposed to leafroll at Highmoor Farm to test their resistance to this disease. A total of 7,200 such potential new varieties have been under test during the past few years.

University of Maine

Orono, Maine

POTATOES

Bulletin No. 420 June, 1943

POTATOES

Potatoes have been for many years an important commodity in Maine's agriculture. The potato yields per acre for Maine are higher than for any other state in the United States, and are exceeded in other countries of the world only by potato yields in Eire, Norway, Netherlands, and Belgium. The soil and climatic conditions in Maine are favorable to high yields of potatoes, but these yields, also, reflect creditably upon the enterprise and leadership of the Maine potato growers themselves. The research of the Agricultural Experiment Station has had no little influence in the development of methods of potato production in Maine including the production of high quality seed stocks, rotation practices, disease control, etc. The cooperation of agencies of the U. S. Department of Agriculture has been very helpful in the outlining and carrying out of this research program. The major emphasis is continued on those problems which appear to be most important at the moment. The value of long-time basic studies is not underestimated.

POTATO DISEASES

Net necrosis and stem-end browning continue to be serious problems for those who grow, or would grow, the Green Mountain variety. Bacterial ring rot, leafroll, late blight, rhizoctonia, scab, and mild mosaic are still problems to many growers. The control methods for all of these diseases have been improved, but much remains to be desired in all of these methods.

Bacterial Ring Rot.[1] Reiner Bonde. Considerable progress has been made in the improvement of Maine seed stocks from the standpoint of stocks free or relatively free of bacterial ring rot. There were fields in Florida in 1937 planted with Maine seed where 26 per cent of the plants had ring rot. More recently, according to Mr. E. L. Newdick of the State Department of Agriculture, 18,000 carloads of certified seed have been shipped to other states with no complaints that ring rot was found or caused losses to the growers.

[1] Grateful acknowledgment is made to the Potato Tax Fund for financial support to the studies on several of the more important potato diseases, to the studies on by-products, and to some extent to the studies on fertilizers and green manure crops for central Maine.

The Effect of Planting Seed Stocks Having a Trace of Ring Rot. Reiner Bonde, Stanislas Snieszko. A study was conducted for the purpose of determining the possible loss to the potato crop which may result from planting seed stocks which are slightly infected with ring rot. One-hundred-pound samples of seed potatoes were received from New York, Nebraska, Minnesota, North Dakota, and Maine. The samples were taken from fields which had approximately 0.1 per cent ring rot according to the records of the certification inspectors. The potatoes were cut and planted in the usual manner. The percentage of disease that was evident during the summer was recorded as well as the rot which was present in the crop when it was harvested.

None of the samples developed more than 1 per cent of the plants which showed symptoms of ring rot and only a trace of decay was apparent when the crop was harvested. This experiment confirms our previously obtained information that seed stocks with traces of ring rot may produce a good crop when grown for the table stock market.

Other experiments, however, have shown that the disease may spread very rapidly. A seed stock with an occasional diseased tuber generally will have 1 per cent ring rot when the crop is harvested, and 10 or 15 per cent or even more ring rot when it is planted successively for two or three years.

This information should discourage growers from planting seed stocks known to have this disease. Ring rot will not be eliminated if growers continue to plant seed known to have the disease. Furthermore, a considerable amount of infected tubers sometimes results even when relatively disease-free stocks are planted.

Varieties Resistant to Ring Rot.[2] Reiner Bonde, Stanislas Snieszko. Approximately 3,500 seedling potato varieties were tested during 1942 for resistance to ring rot. Two foreign varieties and four potato seedlings have been found that are resistant to this disease. In order to check previous information that varieties vary regarding their susceptibility to ring rot, an experiment was conducted in 1942 in which eight varieties were inoculated with the

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[2] The potato breeding program is cooperative with the Bureau of Plant Industry of the U. S. Department of Agriculture. Grateful acknowledgment is made to Doctor H. A. Jones, Doctor F. J. Stevenson, and Robert Akeley, who are the Bureau representatives on this study in Maine.

causal organism under similar conditions. The results of this experiment are as follows:

Variety	Ring Rot Occurring Per cent of plants infected
Green Mountain	82.3
Irish Cobbler	95.0
Houma	100.0
Chippewa	94.0
President	0.0
Seedling #46952	2.0
Seedling #0.55	5.3
Seedling #47102	0.0

The data show clearly that certain newly developed varieties as well as the variety President became infected less readily than did the old standard varieties now being grown in Maine.

The progenies resulting from crossing certain resistant and susceptible parents were tested regarding their susceptibility to the disease. The results of some of the studies made in the field are summarized as follows:

Variety or Cross	Percentage of resistant seedlings in progenies
Green Mountain controls	0 (73% to 100% infected)
Chippewa x Chippewa	0
Sebago x Ostragis	0
Sebago x 336-144	47.0
Houma x 336-144	50.0
Earlaine x 336-144	39.0
41956 x 336-144	48.0
336-18 x Self	81.0
President x Chippewa	75.0
President x 918-12	66.0

These data show that resistance to ring rot is inherited and that a high percentage of resistant seedlings may be expected when the variety President or Seedlings 336-144 and 336-18 are used as parents. These parents, however, do not produce seedlings that are particularly good for other desirable characteristics. The first task is to find parents that are resistant and to learn whether this resistance can be transmitted to new varieties.

The Mechanism of the Resistance of Potatoes to the Ring Rot Disease and the Laboratory Determination of the Susceptibility of Different Varieties of Potatoes. Stanislas Snieszko, Reiner Bonde. Experiments are being conducted on the growth of *C. sepedonicum* (organism causing bacterial ring rot) on the tissue extracts of the potato tubers. Extracts were obtained by crushing the tubers and pressing out the juice. After preliminary straining, the juices from different varieties were sterilized by filtration through bacteriological filters, and the filtrates were used as the basic media for the growth of the disease organism. The extracts of different varieties of potatoes differed very strikingly in their ability to support the growth of this organism. This suggests that varieties resistant to ring rot possess some inherent quality of the juice which inhibits the growth of the organism.

Isolation of the Ring-Rot Bacteria from Decaying Potatoes. Stanislas Snieszko. In potato tubers which show the early symptoms of ring rot the causative organism is found usually in a pure culture and its isolation is, therefore, quite simple. When, however, a potato tuber is found, which due to secondary invasion of various soft rot microorganisms, is completely decayed, it is frequently very difficult to detect whether the tuber was originally infected with the ring-rot bacteria. Many attempts to isolate the ring-rot bacteria from such decayed tubers were unsuccessful, because the organisms causing the soft rot, grew fast and abundant on all media and rendered the growth of the ring-rot organisms impossible. In the course of the research it was found, however, that the addition of sodium dichromate in concentration 1:20,000 made possible the isolation of *C. sepedonicum* from the tubers with advanced secondary decay. This medium was found to be especially useful in the diagnosis of the ring-rot infection in potato tubers which underwent severe rot during the winter storage. Farmers or potato inspectors frequently bring in well rotted tubers for diagnosis. In order to make the diagnosis in such cases certain, it is advisable to use media with the addition of sodium dichromate in proper concentration.

Use of Litmus Milk for the Cultivation of the Ring-Rot Organism. Stanislas Snieszko. It has been found that skim milk with the addition of litmus can be used as a medium in which the stock cultures of ring-rot bacteria can be kept viable for many months. Litmus present in the milk stays reduced as long as the culture is viable. When the litmus begins to become oxidized it is advisable

to make a transfer to a fresh medium. Cultures of this bacterium are necessary for use in testing for resistance of potential new varieties.

Serological Experiments. Stanislas Snieszko. It is a well established fact that if a certain pathogenic bacterium can be divided in several serological (or immunological) groups, usually the immunity acquired against one serological group or type is not effective or only partly effective against a different serological type or variety of the same microorganism. If the ring-rot organism (*C. sepedonicum*) could be divided in several serological types, then most probably different varieties of potatoes would show different degrees of resistance or susceptibility against these various serological types.

Preliminary experiments were made with two agglutinating sera and 19 strains of *C. sepedonicum.* The results indicated that this organism forms a quite uniform serological group, and that the agglutination test may be used for the identification of this bacterium. The practical significance of this finding may be that any variety of potatoes should be equally resistant to the ring-rot disease regardless of the source of the microorganisms. That is, a variety of potatoes found resistant to bacterial ring rot in Maine will also very likely be found resistant in Florida or any other state.

Survival of the Ring-Rot Bacteria in the Soil. Reiner Bonde, Stanislas Snieszko. Pure cultures of the ring-rot organism were added to sterile samples of Caribou loam and Washburn loam soils. Closed jars containing these inoculated soil samples were placed in the field at Aroostook Farm at a depth of eight inches in October of 1941. The jars were removed from the soil in May of 1942 and the soil in the jars was tested bacteriologically. In some of those jars that did not become contaminated with various soil bacteria during the storage in the soil, the ring-rot bacterium was found to be present and virulent.

yes.

From the jars which became contaminated with the soil bacteria, the ring-rot bacterium (*C. sepedonicum*) was not recovered. These results are in general agreement with others obtained in America and Europe which indicate that in the presence of normal soil flora *C. sepedonicum* dies off faster than in a pure culture. Other experiments have shown that in badly disintegrated potato tubers, many soil microorganisms were present besides *C. sepedonicum.* The ring-rot organism apparently died off faster than in

tubers where it was found to be in a pure state. This may help to explain the fact that the soil has not been found to be the carrier of the ring-rot bacteria from one season to another.

Survival of the Ring-Rot Bacteria Under Various Conditions. Reiner Bonde, Stanislas Snieszko. In October of 1942 a series of experiments was begun on the survival of the ring-rot organism (*C. sepedonicum*) in pure culture and under natural conditions in soil and in the potato bins under various storage conditions. The bacteria in pure or crude cultures were used to contaminate soil and jute and cotton potato bags, or pieces of wood (toothpicks). At various intervals the contaminated soil and potato bags were tested for the presence of viable *C. sepedonicum* and for its virulence. Potato seed pieces were inoculated in each case and were grown in the greenhouse. The preliminary results indicate that the ring-rot bacteria survived for several months on either cotton or jute bags. On wood, *C. sepedonicum* died off in a comparatively short time.

Disinfectants and Bacteriostatic Agents. Stanislas Snieszko. A considerable number of disinfectants and bacteriostatic agents have been tried against the ring-rot organism (*C. sepedonicum*). In test tube experiments the growth of *C. sepedonicum* was entirely suppressed by the following materials in the concentrations indicated:

Crystal violet in concentration	1:1,000,000
Brilliant green in concentration	1:100,000
Fuchsin in concentration	1:100,000
Trypan blue in concentration	1:5,000
Coal tar disinfectant concentration	1:10,000—1:50,000
Semesan Bel	1:1,000—1:5,000
Mercuric chloride concentration	1:10,000
Cupric sulfate	1:1,000—1:5,000
Phenol	1:1,000
4-tertiary-butyl-meta-cresol (Kopper's)	1:5,000—1:10,000
U.S. Rubber germicide No. 83	1:5,000
U.S. Rubber germicide No. 590	1:1,000

None of the highly bacteriostatic dyes has been found to be equally effective in protecting the freshly cut and artificially contaminated potato tubers.

LEAFROLL, INCLUDING NET NECROSIS. Leafroll is, of course, a

virus disease to which all of the commonly grown potato varieties are susceptible. Some of the newer varieties, such as Katahdin, Chippewa, and Houma, are susceptible to leafroll but do not develop net necrosis in the tubers. These varieties may be considered to be resistant to this extent.

Leafroll, including net necrosis, is one of the most serious problems of the potato grower. Every effort is being made to develop a means for eliminating this disease. Resistant varieties are a definite possibility but can be developed only in a relatively long-time program. Other possibilities are aphid control, isolated seed plots, roguing, early harvesting, etc.

Resistant Varieties. Donald Folsom. The tests for leafroll resistance are made each year at Highmoor Farm. Several thousand seedlings have been tested over a period of years. These seedlings are supplied from the potato breeding program which is cooperative with the U. S. Department of Agriculture. The Green Mountain and Chippewa varieties are grown for comparison and to supply a source of the leafroll disease.

The extent to which leafroll has spread is ascertained by harvesting samples in any one season and growing these the following season in the field. The readings made in 1942, therefore, are for the leafroll contracted in the 1941 growing season. These readings in the summer of 1942 showed that 79 per cent of the Green Mountains, 91 per cent of the Chippewas, and 85 per cent of seedling varieties contracted leafroll in 1941. The 85 per cent for the seedlings maintains a high rate (69 per cent in 1938, 81 per cent in 1939, and 87 per cent in 1940).

The seedlings have come from crosses between varieties mostly chosen for having shown some resistance to leafroll. Five thousand five hundred and eighteen seedlings have been exposed at Highmoor Farm up to 1941 inclusive with results known as to leafroll resistance. All but about 5 per cent of these have taken leafroll. However, seedlings resistant to the first year or two of exposure usually take leafroll only lightly, thus indicating some resistance. Some of the seedlings that have resisted leafroll for two or more years are much more vigorous than commercial and seedling varieties that are susceptible and that have taken the disease. The seedlings first exposed in 1942 (1,273 in number) were mostly from crosses with Dakota Red as one parent, a variety reported to be resistant to leafroll. The seedlings to be exposed for the first time

in 1943 are all from crosses between seedlings found resistant at Highmoor Farm, or between such seedlings and commercial varieties, and should be resistant in higher proportion than any group tested so far.

Some of the resistant seedlings have tubers of good type and size produced at an apparently good yield rate, and with some promise of good cooking qualities. Five of the resistant seedlings are to be planted at McNally in 1943 in order to obtain an increased quantity of seed stock for distribution to growers in case tests on yield, etc., justify such distribution.

Selection for Resistance to Net Necrosis in Green Mountains. A. Frank Ross. Approximately 400 tuber line selections were started during 1942. Two seed pieces from each tuber line were planted in a propagation plot and two other pieces from the same tuber in an exposure plot. The crop from the latter was examined for net necrosis and will be planted this spring for leafroll readings. Those tuber lines showing a low NN/LR[3] ratio as well as those showing a high ratio will be selected. Healthy tubers (of these selections) from the propagation plot will be planted in a 1943 propagation plot as well as in an exposure plot. Hence further selection will be obtained each year. In addition to these tuber lines, those obtained in the SEB[4] selection experiment will be introduced into this program so selection for resistance to both SEB and NN can be attempted.

Storage Temperatures and Net Necrosis. Donald Folsom, Michael Goven. The results of the 1942-43 storage period check with those of past seasons. Samples of potatoes from fields which apparently had considerable leafroll spread show considerable net necrosis even at low storage temperatures such as 31°-36° F. Potatoes from one field had 36.2 per cent of net necrosis when stored at 53° F. but only 15.3 per cent when stored at 31° F. Potatoes from this particular field when stored at 36° F. showed 20.0 per cent net necrosis or in other words only a little over half as much net as was found in those stored at 53° F. Potatoes from another field showed 0.7 per cent net necrosis at the 36° temperature and 15.0 per cent net necrosis at the 53° temperature. (See Table 1.)

The peak of the net necrosis development may be any time

[3] NN stands for net necrosis and LR stands for leafroll.

[4] SEB stands for stem-end browning.

from the middle of December to the latter part of January on the basis of data obtained this year.

A new storage temperature relation discovered this year shows promise. Potatoes were held at around 70° F. for 60 days and then the temperature was reduced to about 51° F. These potatoes developed considerably less net necrosis than did samples of the same lots held steadily at 51°. For instance, potatoes from one field showed 9.4 per cent net necrosis when held steadily at 53° F. for 30 days and 15 per cent had developed at the end of 90 days. When held at 70° for 60 days and then 30 days at 50° the potatoes developed only 1.9 per cent net necrosis. Samples of potatoes from three other fields showed similar behavior. This may be an important discovery since it would be relatively easy to warm the potatoes for a short period before attempting to lower the storage temperature.

Mahogany Browning and Leafroll. A. Frank Ross, Merle T. Hilborn. In previous work on mahogany browning in storage it was found that the Chippewa and Katahdin varieties were the most susceptible when stored at 32° F. Green Mountains at 32° F. showed no discoloration. The location of this injury in the tuber was different if leafroll was present. Chippewas with leafroll usually showed a more severe discoloration in the cortex than elsewhere in the tuber. Healthy Chippewas, however, usually showed the discoloration only in the vascular ring and pith. In most cases the pith was more severely affected, with the discoloration appearing as scattered spots. There was about a 6 or 7 week time lag in the appearance of typical symptoms between tubers grown at Highmoor Farm in southwestern Maine and those grown in Aroostook County. Apparently the rate of development of this discoloration was influenced somehow by the locality in which the tubers were grown. Before the end of the storage period, the percentage of affected tubers was about equal regardless of source.

In the 1942-43 storage experiments potatoes were stored at 32° F. and also at 30° F. The varieties used were Green Mountain, Chippewa, Sebago, Cobbler, and Katahdin. Each of these was represented by one lot of stock that was apparently free from disease (usually foundation seed) and a second lot of stock that was high in leafroll infection. The following is a brief summary of the results by variety.

Green Mountain. At 32° F. no internal discoloration of any kind appeared in storage even at the end of 20 weeks. At 30° F. an internal discoloration appeared which usually varied from a slate color to almost black. In only a very few cases did the color approach the typical reddish-brown discoloration found in Chippewas. In leafroll Green Mountains the discoloration was usually more localized in the cortex while in healthy tubers the discoloration usually appeared in the vascular ring and the tissue immediately beneath the ring.

Chippewa. At 32° F. typical mahogany browning appeared in about 60 per cent of the stock at the end of 20 weeks of storage. The results were consistent with previous data. In leafroll tubers the discoloration was more severe in the cortex, and in some cases was restricted to that tissue. In healthy tubers the discoloration usually appeared in the pith and then only as scattered spots. In every case the discoloration was typical mahogany browning, i.e., reddish-brown in color. At 30° F. the discoloration appeared earlier in the storage period.

Sebago. No difference could be observed between healthy and leafroll infected tubers. At the end of 20 weeks a discoloration appeared that was similar in color to that observed in Green Mountains. This discoloration appeared first in tubers at 30° F.

Cobbler. During 20 weeks storage no discoloration appeared in any of the experimental lots. After an additional 10 weeks storage a high percentage of the tubers developed a discoloration similar in appearance to stem-end browning.

Katahdin. No difference could be observed between healthy and leafroll infected tubers. At the end of 20 weeks in storage a discoloration would appear that was similar to that found in Chippewas, i.e., a typical mahogany browning. This discoloration appeared first in tubers stored at 30° F.

In previous work, and again in the 1942-43 season, it was noticed that there was a time lag in the appearance of typical symptoms between tubers grown in various localities. In 1942-43 internal discoloration appeared first in tubers grown in southwestern Maine, then in tubers grown in central Maine, and finally in tubers grown in Aroostook County. Studies are in progress to determine if the rate of leafroll spread is responsible for this time lag. Plant-

ing tests are also being conducted to study the possible relationship between leafroll and the type of internal discoloration caused by storage at 30° and 32° F. The incidence of mahogany browning appears promising as a means of detecting leafroll infection in Chippewas, but the method shows little promise of being adapted to use with the Cobbler, Sebago, and Katahdin varieties.

Tests for Leafroll Virus in Tubers. A. Frank Ross. An attempt has been made to develop tests for the detection of leafroll virus in tubers. A hundred or more tests have been examined and while some gave a degree of correlation, only a few show promise of being dependable. At the present, two tests are being examined carefully. Both are simple and capable of being applied to a thousand or more tubers a day with a three or four man crew. One test appears to work well for Green Mountains and Cobblers. The other seems to work satisfactorily with Katahdins. Sufficient data have not been obtained to warrant definite recommendations but the methods show promise. Neither test is satisfactory for Chippewas although modifications of these as well as other tests are being tried.

Aphids and Their Control.[5] Geddes W. Simpson, Charles L. Hovey, Wayland A. Shands, Theo E. Bronson. The work with aphids was conducted at Houlton and at Presque Isle. The work at Houlton was confined to spraying and dusting for the control of potato insects. This season, the use of rotenone dusts resulted in considerably increased yields. The sprays containing rotenone were less effective than the dusts. Samples from the various plots were not sent to Florida, so no information on the spread of leafroll is available at this time.

The work at Presque Isle dealt with a study of the aphids themselves. A survey of wild plum, the overwintering host of the peach aphid, was carried out in May. It revealed that plums are quite abundant but are largely limited to easily accessible locations. Large colonies of the peach aphid were found on plums in early June. They began to leave the plums in early June and went to emerging potatoes and to various weeds, mustard and kale in particular. They multiplied abundantly on these weeds throughout

[5] The studies with aphids are cooperative with the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture. Mr. W. A. Shands and Mr. T. E. Bronson are the Bureau representatives on this study in Maine.

July. Beginning the latter part of July they flew from weeds to potatoes and considerable spread of leafroll in the potato crop resulted.

A greenhouse study showed that single mustard plants, infested by single peach aphids, after a period of time, produced an average of 2,517 winged peach aphids. The studies on weed hosts indicate clearly the need for much better weed control on the part of the farmer. Perhaps the most helpful information is that indicating the need for preventing kale and mustard from reaching a stage where they come into flower. In fact, the study indicated that emphasis should be placed upon controlling these weeds while they are seedlings. Most growers are inclined to wait too long before attempting to pull these weeds.

A study of the relative production of winged aphids by Green Mountain and Katahdin potatoes showed that winged green peach aphids were produced earlier and more abundantly on Katahdins than on Green Mountains although the latter were larger plants and had more leaf surface than the Katahdins.

A survey of aphid eggs on primary hosts, such as wild plum, in the fall failed to disclose as many as were found in the same locations in the spring.

An aphid trap developed a year ago was used extensively in various parts of the County in an endeavor to learn more about aphid flight. Much larger numbers of aphids were taken in 1942 than in the previous season. In one trap located near Presque Isle a total of more than 92,900 aphids were taken during the season. Traps were operated at several different heights above the ground and it was found that there was but little difference in the numbers of winged aphids taken at the various heights up to 26 feet above the ground. This indicates that small distances may afford very little protection to seed fields when aphids are flying from table stock fields in the vicinity.

Some time was spent studying the natural enemies of aphids. These are numerous and often quite effective but usually they begin to operate somewhat too late for practical purposes.

Considerable attention has been given to the control of aphids as a means of reducing the spread of leafroll. The four species of aphids involved are the green peach aphid, *Myzus persicae;* the buckthorn aphid, *Aphis abbreviata;* the potato aphid, *Macrosiphum solanifolii;* and the foxglove aphid, *Myzus pseudosolani.*

Weather conditions in the Houlton area during 1942 were a major factor in determining the nature of the aphid infestation. The infestation in the various experimental plots was comparable to that of 1941 but very much lighter than the severe infestation of the 1940 season.

The degree of aphid control on the plots treated throughout the season with the spray mixture containing rotenone was not entirely satisfactory, ranging from 14 per cent to 76 per cent. This, it is thought, was partly due to inadequate spraying equipment. The increases in potato yields of plots treated with insecticidal spray over the check plots sprayed only with fungicidal materials were not very encouraging, although the increase on one farm was 12.6 per cent. (See Table 2.)

The tests on the plots treated with dust mixtures containing rotenone throughout the season, however, resulted in a very high degree of aphid control even on plots where the dust was applied with rather inadequate equipment. Aphid control for the season ranged between 91 and 95 per cent. The increase in the yield of plots dusted with material containing an insecticide and the check plots, treated with the usual fungicide only, ranged from 17.3 per cent to 47.5 per cent. (See Table 2.)

Late blight appeared early and was particularly severe on some of the farms where the experimental plots were located. The control of late blight where derris was added to the fungicide was decidedly superior to that obtained on plots treated with the fungicide alone.

Several insecticides were given preliminary tests. These were judged only on the basis of reduction in the aphid infestation 2 or 3 days after a single application. On this basis, the most effective insecticidal material under test in the 1942 season was the derris-soybean oil combination. Nicotine sulphate and derris without oil also were very effective when judged by this method. The insecticides used were combined with a neutral copper fungicide.

Machine for Early-Harvesting Operations.[6] John W. Slosser. Early harvesting has been found to be one of the most effective means of preventing leafroll spread. An attempt is being made to develop a machine to do this job, and one will be available for trial

[6] This study is cooperative with the Soil Conservation Service of the U. S. Department of Agriculture. Mr. John W. Slosser is the Soil Conservation representative on this study.

this summer. The machine is being designed to cut the vines so as to leave a stubble not more than two inches high. It is being designed to attach a burner or a weed killer sprayer to make the stubble unpalatable to aphids. Various combinations are possible. Should this machine prove practical, one man could early harvest four or five acres per day easily enough. We believe this machine has promising possibilities.

Fertilizer and Crop Rotation as Related to Net Necrosis Development. Joseph A. Chucka, Arthur Hawkins, Michael Goven. The potatoes used in this study came from two general sources. One group of samples was from the permanent plots on Aroostook Farm and the second group came from plots on private farms. The seed stock for the permanent plots was from a farm where considerable difficulty had been experienced with stem-end browning. At planting time the tubers were sorted into two lots, one lot with stem-end browning and one lot without this defect. Apparently this selection for stem-end browning had no effect upon the development of net necrosis in the crop harvested.

PERMANENT PLOTS. Potato samples from some of the Aroostook Farm plots were stored at two temperatures, one lot at 50° F. and the other at 36° F. There was considerably more net necrosis in the potatoes stored at the higher temperature regardless of fertilizer treatment.

In the potatoes held at 50° F. comparatively little net necrosis developed in the lots from plots which received no fertilizer.

Net necrosis percentages increased with an increase in the rate of application of fertilizer to the various plots. Potatoes from the plots receiving 1,500 pounds of 4-8-8 had 12 per cent net necrosis and those from plots receiving 3,000 pounds of 4-8-8 had 25 per cent. (See Table 3.) In the various fertilizer ratio tests there was an increase in net necrosis with an addition of nitrogen and with an addition of phosphorus in the ratios from 0 to 6 and 0 to 12 respectively. In the potash series there was almost four times as much net necrosis in the 4-8-12 plots as there was in the 4-8-0 plots. The increases in the percentages of net necrosis, however, were not consistently correlated with each added increment of any one of the three fertilizer elements. The source of nitrogen apparently had little or no effect on net necrosis development.

The source of potash, however, continued to be an important matter. Potatoes from plots receiving potash from potassium

chloride developed twice as much net necrosis as did potatoes from plots treated with potassium sulfate. These plots, however, have been fertilized with the same source material since 1928. On the plots which have had potassium chloride since 1928 and had potassium sulfate in 1942 for the first time there was practically no reduction in net necrosis.

The potatoes from plots fertilized with chemically pure salts developed only about half as much net necrosis as did potatoes from comparable plots receiving the ordinary fertilizer mixture. This chemically pure salt mixture contains no chlorine, fluorine, or sulphur all of which are present in the ordinary fertilizer.

PLOTS ON PRIVATE FARMS. Three lots of tuber samples were harvested at each of five different dates from a uniform field of potatoes and were stored under three different conditions. One lot was stored at 36° F., a second lot at 50° F., and the third lot at a variable temperature corresponding to the temperature of the soil during the harvest period. In other words, soil temperatures were taken daily and the temperature of this third storage bin was varied to agree with the temperature of the soil. This bin was started at about 65° F. and was gradually lowered to about 36° F. and was maintained thereafter at the 36 degree temperature.

Net necrosis development in the samples harvested at different dates did not increase as might be expected as harvesting was later. In fact, there was less net necrosis developed in the samples harvested in October than developed in those harvested in early September. (See Table 5.) There was a lower development of net necrosis in all samples held at the 36° F. temperature than for either of the other lots. (See Table 4.) The lot harvested on September 2nd and held in the bin at the soil temperature showed the highest net necrosis, 21.9 per cent.

A test was made in these plots on private farms on the source of potash. Four 5-8-12 fertilizers were compared, each with a different source of potash. One had all the potash from the muriate, a second had half from the muriate and half from sulfate, a third had all of the potash from the sulfate, and a fourth had potash derived from potassium metaphosphate and potassium nitrate. The test was made on two farms. The net necrosis development was considerably lower in the plots on which the potash came from potassium metaphosphate and potassium nitrate. These plots had

an average of 7 per cent net necrosis while the plots treated with muriate of potash had an average of 16 per cent. (See Table 6.)

Several uncommon elements, such as barium, lithium, and strontium, were tried in the fertilizer for their effect upon the development of net necrosis. None of those tried appeared to have any appreciable effect on net necrosis development. (See Table 7.)

Foundation Seed. Wesley F. Porter, Geddes W. Simpson. The Foundation Seed Program was started in 1939. It is an attempt on the part of Maine seed growers to provide themselves with better sources of seed and to stimulate interest in the manner in which good seed may be grown year after year. The Experiment Station provides supervision only.

The experience gained over a period of years makes it possible to offer to growers a number of recommendations for the successful growing of foundation seed potatoes. A summary of these recommendations is as follows: (1) A source of seed free of ring rot and with a low virus disease count; (2) isolation from other potatoes; (3) early planting; (4) planting by tuber unit method; (5) early and complete removal of all diseased plants; (6) clean cultivation; (7) early harvesting; (8) testing sample to insure quality of seed for next year's planting. Growers who follow these recommendations may be reasonably well assured of satisfactory seed. The neglect of any one of these recommendations may make it impossible to get satisfactory results, especially in years of a heavy aphid infestation.

In 1942, 35 growers entered approximately 230 acres in the seed program. The acreages and the varieties entered were 85.1 acres of Green Mountains, 53.4 acres of Sebagos, 37.2 acres of Katahdins, 24.2 acres of Irish Cobblers, 19.2 acres of Chippewas, 7.3 acres of Houmas, 1 acre of Sequoias, 3 acres of Mesaba. The plots varied in size from .3 acre to 20 acres. The total acreage entered was planted in 86 different plots. The plots were located in the Counties of Aroostook, Penobscot, and Piscataquis.

Planting dates ranged from May 4 to June 4. Eighty per cent of the plots were planted on or before May 20. Owing to heavy rainfall a number of plots located in northern Penobscot County were not planted until after May 20.

Each plot was rogued once a week for a period of six weeks beginning in some plots on June 20th. Nearly all plants showing leafroll symptoms were removed from the plots by July 15. Ring

rot was found in one plot about August 15. The roguing was completed on all fields by August 11.

Experience has shown that early harvesting is one of the most important factors in the control of the leafroll disease. Owing to an early migration of aphids, early harvest seed for planting in 1943, was taken earlier than in any previous year, dates ranged from July 30 to the week of August 15. Seed for another year's plot was taken from areas within the field as far away as possible from diseased units removed during the roguing season.

Several growers early harvested the entire acreage entered by them in the program. The wisdom of this practice is verified by the results of the current Florida test. All samples from early harvested plots showed a virus disease content well below the tolerance recommended for seed to be planted for certification. (See Table 8.) The yield per acre from early harvested fields ranged from 50 barrels per acre for some fields of the Irish Cobbler and Sebago varieties, to 110 barrels per acre for the Chippewa variety. Some fields of Sebagos and Green Mountains yielded 100 barrels per acre at early harvest time. In the 1942 program approximately 6,000 barrels of seed were early harvested for planting in 1943. A few growers have enough seed to plant their entire acreage.

As a result of the readings obtained on the samples grown in Florida and in the greenhouse at Presque Isle, seed grown on 73 per cent of the acreage entered in the Foundation Program in 1942, was recommended for planting fields to be certified in 1943.

Florida Test Plot. Wesley F. Porter, Geddes W. Simpson, Donald Merriam. During the winter of 1942-1943, the Station, in cooperation with the State Department of Agriculture, conducted a Florida test in the vicinity of Aladdin City, Florida. The purpose of this test was to determine as accurately as possible the probable amount of disease present in potato seed stocks to be grown in Maine in 1943 and to be entered for certification.

One hundred seventeen different growers entered a total of 403 samples in the 1943 test. Seventy-four of the samples entered were taken from plots entered in the 1942 Foundation Program. Three hundred twenty-nine samples were taken from tuber unit seed plots or from fields that were certified in 1942. The acreage and varieties represented by the samples were 43 acres of Bliss Triumphs, 796.5 acres of Chippewas, 68.5 acres of Houmas, 1,578 acres of Green Mountains, 1,510.8 acres of Irish Cobblers, 1,009.4

acres of Katahdins, 513.1 acres of Sebagos, 16 acres of Russets, 9 acres of Pontiacs, 12 acres of Earlaine No. 2, 22.5 acres of Sequoias, and 6 acres of Warbas, the total acreage represented being approximately 5,584 acres.

Samples were taken from the foundation plots by members of the Station Staff. The sample consisted of 400 or 800 four-ounce tubers. The number of tubers in the sample taken depended on the size of the plot. Four hundred tubers were taken from plots of one acre or less. If the plot was over an acre in size, 800 tubers were taken. Nearly all of the samples were dug by hand, taking one tuber from a hill and selecting the 400, or 800 hills, at equal intervals throughout the field. The samples from fields that were early harvested were taken about 12 to 14 days after the tops had been pulled. If the tops in a field were still green at digging time, the sample was taken the day before digging, or behind the digger as the field was dug.

The samples from the fields that were certified in 1942 were taken by the grower. The cost to the grower for each sample tested was $15. The grower was instructed to take the sample at digging time by taking one four-ounce tuber from each barrel as it was hauled into the storage house. If the grower had three or four barrels of tubers when he was through digging the field, he was instructed to take a proportional number from each barrel to make up his sample of 800 four-ounce tubers. As in previous years, a few growers selected tubers weighing six to eight ounces. As a result, the sample had 500 to 600 tubers instead of the 800 tubers recommended.

It was recommended that the sample should not represent a field of more than 20 acres. About 80 per cent of the samples in the 1943 test represented fields varying in size from one half acre to 20 acres.

The samples were collected on October 1 and transported to Aroostook Farm, Presque Isle. They were sorted, sacked, and given a gas treatment with ethylene chlorohydrin to break the rest period of the tubers. All of the varieties except Irish Cobblers and Russets were given a five-day gas treatment. The Irish Cobblers and Russets were placed in a tightly closed bin. The tubers were warmed to a temperature of 72° F. for a period of one week before the gas treatment was started. A high relative humidity was maintained during the treating period.

By taking advantage of an early season, planting in 1942 was completed by November 25. Each sample was planted in a row by itself. Twenty-two acres were needed to plant the test. The tubers from each sample were planted whole.

Owing to the length and normal appearance of the sprouts on the tubers of the Irish Cobbler and Russet varieties, the practice of cutting off the ends of each tuber to make them more permeable to water and stimulate sprouting was not carried out on all samples in 1942. Ten samples were cut as a check. There was little noticeable difference in the emergence and growth of the samples cut and those that were uncut. The difference, if any, was in favor of cutting. Primary roots or feeders had formed at planting time on the sprouts of the bruised tubers in a number of the Irish Cobbler samples.

Favorable weather conditions and the earliness of the Irish Cobbler and Russet varieties made it possible to complete the readings on the test by January 16. Final readings were obtained on the Chippewa and Sebago varieties the first week in January.

In general, the leafroll virus was found in much higher percentages than the other virus diseases. The Chippewa variety showed the highest percentage of leafroll. Katahdins showed the lowest disease count. One plant was found in the Katahdin variety that showed early symptoms of purple top.

A summary of the number of lots of seed by variety and acreage entered in the 1942-1943 Florida Test and the number of lots and acreage recommended for planting as certified seed and table stock in 1943, are given in Tables 9, 10, and 11.

It is of interest to note that 38 per cent of the total acreage entered in the 1943 test did not exceed 2 per cent leafroll and 3 per cent mosaic. Seventy-eight per cent of the total acreage did not exceed 10 per cent leafroll.

Chippewa Test Aroostook Farm Greenhouse. Chas. L. Hovey, Geddes W. Simpson, Wesley F. Porter, Reiner Bonde. It was considered desirable to make a greenhouse test of all the acreage of the Chippewa variety entered for certification in the 1942 crop season. This program was arranged at the request of and in cooperation with the State Department of Agriculture and was conducted in the greenhouse at Aroostook Farm. Sixty-six samples of at least 200 tubers each were planted for observation. These represented the entire acreage of Chippewas grown for cer-

tification in 1942. A single sample represented anywhere from 3 to 77 acres. One hundred tubers of each sample were planted during the first week in November and the second 100 tubers were planted about the middle of January.

Due to the short daylight hours at the latitude of Presque Isle during November and December the plants produced were somewhat abnormal and the symptoms of virus diseases, particularly those of leafroll, were difficult to detect. However, a reading was made of the amount of disease in each sample. While it was easy to separate the samples of high disease content from those of low disease content, it is believed that considerable experience in reading leafroll symptoms must be obtained before the best results can be achieved in the greenhouse during December and January.

The second planting was made in January. Growing conditions were markedly improved for this planting due to longer days and consequently more hours of sunlight during the months of February and March. The disease reading which was made in early March is believed to be a more accurate index of the disease content than the reading made on the first planting. A check on the individual fields the following season must be made, however, in order to substantiate this assumption.

The amount of leafroll in the two readings for each sample was averaged. It was found that of the 66 samples tested, 39 contained 20 per cent or less leafroll, 21 contained 10 per cent or less and 8 contained 5 per cent or less.

Ratio of Net Necrosis to Leafroll in Green Mountain Potatoes. Reiner Bonde, Geddes W. Simpson. Leafroll and net necrosis often are limiting factors in the production of Green Mountains for market in Maine. The presence of a relatively small amount of net necrosis in table stock potatoes will put it out of "U.S. 1" grade and the buyers demand that seed potatoes be relatively free from leafroll and net necrosis. The question naturally follows: How much leafroll may be expected in seed stocks having a known amount of net necrosis? Some information pertaining to this problem was obtained from experiments performed in 1940 and 1941.

During the seasons of 1940 and 1941 fields of Green Mountain potatoes were sprayed with different copper fungicides and with combinations of these fungicides containing rotenone for the control of aphids. Samples of potatoes from each treatment were put into storage under conditions that were favorable for the development

of net necrosis. The tubers, after having been in storage throughout the winter, were cut and examined for the presence of net necrosis. The same samples were then planted in the field and the percentages of leafroll found were recorded. The data secured from these experiments are summarized in Table 12.

The ratio of net necrosis to leafroll in 1940 was 1:4.51. Stated differently, there was one tuber with net necrosis for 4.51 tubers which actually had the leafroll disease. In 1941 the ratio of net necrosis to leafroll was 1:2.82.

STEM-END BROWNING. Stem-end browning is only slightly less objectionable in table stock than is net necrosis. There has been found no means of predicting where or under what conditions one may experience difficulty with stem-end browning. A few things have been discovered which can be fairly effective in controlling the development of this defect.

Storage Temperatures and Stem-End Browning. Donald Folsom, Michael Goven. The results here as with net necrosis agree with results of past years. Stem-end browning development will vary from one field to another. Potatoes from one field were found to have around 40 per cent when the storage temperature was around 52° F. while those from another field had only about 6 per cent. (See Table 1.) Practically no stem-end browning was found at digging time in four fields under observation. The soil temperature at digging time was found to be slightly below the temperature best suited to the development of stem-end browning. The development of this defect in the samples of potatoes from four fields 90 days after digging was found to be 1.7 per cent, 1.6 per cent, 1.5 per cent, and 0.4 per cent when the potatoes were stored at 36° F. Samples from these same fields had 21.7 per cent, 39.5 per cent, 6.4 per cent, and 15.9 per cent, respectively, when the potatoes were stored at 51° to 53° F. (See Table 1.) Apparently, therefore, one can prevent most of the development of stem-end browning if he can get the storage temperature down to around 36° or slightly below.

Apparently the same relation holds with stem-end browning development as with net necrosis development in the matter of warming the potatoes to 70° F. for 60 days before the storage temperature is finally reduced. It will be desirable to test for periods of 10 days to two weeks for this 70° conditioning period. Potatoes from the four fields under observation had 1.0 per cent, 0.9 per cent,

2.1 per cent, and 1.8 per cent stem-end browning when held 60 days at 70° F. and then held for 30 days at 50° to 51° F. Potatoes from the same four fields held at 53° to 55° F. for 30 days had 8.2 per cent, 23.3 per cent, 4.8 per cent, and 5.1 per cent respectively affected with stem-end browning; and when held at 51° to 53° F. for the full 90 day period had 21.7 per cent, 39.5 per cent, 6.4 per cent, and 15.9 per cent respectively affected with stem-end browning.

Clear-Fleshed and Stem-End Browning Seed. A. Frank Ross. A comparison was made of stem-end browning seed and clear-fleshed seed to see if the defective seed would produce a crop of tubers with more of the defect than was produced by clear seed. The 1942 results confirm those of last year. With Cobblers, the two types of seed gave equal amounts of stem-end browning. In the case of Green Mountains, three lots gave no difference while one lot did give a very significant difference in the two types of seed planted. In the latter case the stem-end browning seed produced about 50 per cent more stem-end browning than did clear-fleshed seed. These results indicate that it would not be advisable to discard the affected tubers for seed. Since a difference is sometimes obtained, however, it may be of importance in determining the cause of stem-end browning. Bushel samples grown from stem-end browning seed in 1941 continued to produce more stem-end browning than samples grown from clear-fleshed seed of the same lot. The original lot gave a difference between stem-end browning and clear-fleshed seed in 1941.

Source of Seed and Stem-End Browning. A. Frank Ross. Green Mountain seed was obtained from several growers in Maine, in other states, and in Canada. These lots were planted on Aroostook Farm. Some lots produced as high as 45 per cent stem-end browning, others as low as 3 per cent. Similar results were obtained on different plots. A lot that produced a high percentage of stem-end browning on one plot, did likewise on other plots. Low producers on one plot were also low producers on other plots. In general, lots from the eastern states and southeastern Canada gave a high percentage of stem-end browning, although there were exceptions. A few lots from Maine and Prince Edward Island produced less than 10 per cent stem-end browning. The lowest percentage was obtained from a northern midwestern state. The latter, together with a high producing lot, were planted in a field cage. The same differential was obtained as on open plots.

Effect of Size of Seed Tubers, Date of Harvest of the Seed and Seed Storage Temperatures on Stem-End Browning in the Crop. A. Frank Ross. It appeared possible that the above factors might possibly account for the tendency of different lots to produce different amounts of stem-end browning. One lot of Green Mountains was graded according to size and the different size groups planted on a randomized plot. No effect of size was observed. From one field of Green Mountains, samples were dug at six different dates at approximately two week intervals. Each sample was divided and one half stored at 36° F. and the other at 52° F. In the spring they were planted on a randomized plot. There was no significant difference in the amount of stem-end browning produced by the various samples. Hence, it appears that these factors are not important in determining the amount of stem-end browning produced.

Selection for Resistance to Stem-End Browning in Green Mountains. A. Frank Ross. It was considered possible that the different behavior of different lots might be due to the existence of different strains or tuber lines differing in susceptibility to stem-end browning. Twenty-one lots of Green Mountains from different sources were planted on one plot in tuber units. These were dug separately, stored at 50° F. and examined for stem-end browning. Of the approximately 1,000 tuber lines thus obtained, approximately 150 with high stem-end browning and an approximately equal number with very low stem-end browning content have been selected. These will be propagated from year to year and the amount of stem-end browning produced by each recorded. Single hills were taken from the permanent plots on Aroostook Farm. Hills with a high stem-end browning content were taken from plots that usually give a low percentage of this defect; hills with a low stem-end browning content were selected from plots that usually give a high percentage. By taking these extremes, better selection should be obtained. These tuber lines will likewise be propagated from year to year.

Single hill selections obtained in 1941 were planted again in 1942. Of 38 tuber lines that produced no stem-end browning in 1941, eleven likewise produced no stem-end browning in 1942. Of 42 tuber lines that produced stem-end browning in 1941, 34 also produced stem-end browning in 1942. While a high degree of selec-

tion is not indicated, some was obtained, since eleven tuber lines were maintained free of stem-end browning.

Virus Infection as a Possible Cause of Stem-End Browning. A. Frank Ross. Green Mountains were again grown under a field cage. While less stem-end browning was produced under the cage than outside or in an adjoining shaded area, the results cannot be considered significant for the cage drastically altered growing conditions. Tops grew long and spindly while yield was very poor. Shading was not sufficient to produce the same type of growth. However, the fact that the ratio of stem-end browning produced by a high stem-end browning producing lot to that produced by a low stem-end browning producing lot was approximately the same inside and out of the cage indicates that the seed factor is more important than any spread of virus by insects.

It is possible that the lots producing different amounts of stem-end browning may differ in the type of latent mosaic virus they contain. One of the high stem-end browning producing lots is characterized by a type of latent virus different from the one found in the original Green Mountain. This strain has been widely distributed in Maine.

Chemical Analysis. A. Frank Ross. Further analyses have failed to confirm the earlier report that stem-end browning tubers are lower in copper content than normal ones. There is no consistent difference in the copper content of the two types. No consistent differences were found in the calcium or chloride content of stem-end browning and normal tubers taken from the same lots.

Relation of Chloride Content of Stems of Single Hills to the Amount of Stem-End Browning Produced by the Hills. A. Frank Ross, Arthur Hawkins. Stem samples were taken from single hills on each of three fields while the tops were still green. At digging time the tubers were dug and stored at 50° F. On a given field there was no correlation of chloride content of the stems with the amount of stem-end browning produced. However, the field averages gave a negative correlation. One field gave 72.4 per cent stem-end browning and a chloride value of 3,670 ppm. Values for a new field on the same farm were 22.2 per cent, and 5,995 ppm respectively. The other field was intermediate in both values. Hence, if high chloride tends to produce high stem-end browning, as is indicated by other data, the effect is not direct for stem-end browning is not a function of the amount of chloride absorbed. The

fact that this defect was obtained on new land (first time in potatoes) indicates that it is not necessarily produced by the cumulative effect of any particular fertilizer practice over a number of years. The fertilizer used on this piece of new land, however, contained considerable chlorine, muriate of potash being the source of potash.

Effect of Seed Spacing on Stem-End Browning. A. Frank Ross, Joseph A. Chucka. The Green Mountains from the Aroostook Farm Seed Spacing Variety Tests were examined again this year. There was less correlation of size with stem-end browning than last year, but again the smaller tubers contained less of the defect. Seed spacing had little or no effect. In contrast to results from the permanent plots, rate of fertilizer application had no effect on the amount of stem-end browning. However, in this case the proportion of potassium chloride (KC1) was greater (8-16-20) and fertilizer treatment was not constant in recent years.

Boron Deficiency in Potato Tubers and Its Relation to Stem-End Browning. Frederick B. Chandler, A. Frank Ross. Green Mountain potatoes were grown in sand in the greenhouse and supplied with nutrient solutions by the continuous flow method. The concentration of the solution was varied for some cultures and in others the amount of particular elements was varied. After storage at 52° F. for 100 days the tubers were examined. Stem-end browning was not found in tubers grown with the regular treatment, but it was found to some extent in others. It was most frequently observed in the tubers grown in the solutions with low boron (0.01 and 0.001 ppm). In addition, some of the tubers showed a more severe type of boron deficinecy which also developed in storage. The skin developed a thick, corky russeting, particularly near the stem end, while the skin of others was a brownish black. When these tubers were cut the tissue immediately below the skin was necrotic. The black necrotic area extended from the skin to the vascular ring or deeper (Fig. 1). No symptoms of boron deficiency were observed on the tops of plants grown in the greenhouse. These results indicate that stem-end browning may be the first evident symptom of boron deficiency in potato tubers and that with a greater deficiency the skins are conspicuously russeted and /or the tissue just below the skin is necrotic.

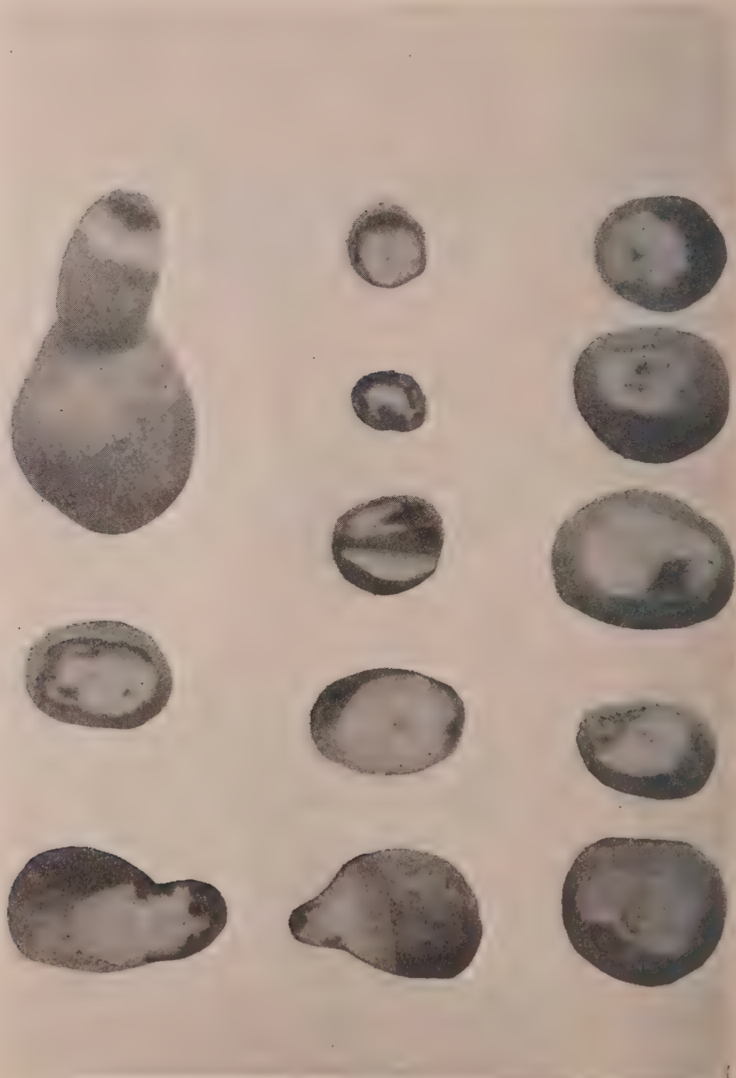

FIG. 1. BORON DEFICIENCY IN POTATO TUBERS.
The two columns of potato tubers on the left show boron deficiency in potato tubers. Those in the column on the right show stem-end browning. All tubers are from plants that received 0.001 ppm of boron.

Fertilizer and Crop Rotation as Related to Stem-End Browning. Joeph A. Chucka, Arthur Hawkins, Michael Goven.

1. PERMANENT PLOTS AT AROOSTOOK FARM. *Effect of stem-end browning in seed used.* These plots were planted with Green Mountains from a source of seed previously found to be highly susceptible to stem-end browning. Before planting, the seed was divided into two lots, one consisting of clear-flesh tubers and the other of tubers having stem-end browning. Half of each of the permanent plots was planted with the clear-flesh tubers and the other half with stem-end browning tubers. One barrel samples of tubers were saved from the two halves of each of the 55 plots and examined for stem-end browning after storage for several months at 50° F. in the experimental storage bins at Aroostook Farm. The readings on the various plots ranged from 2 to 52 per cent from the plots planted with clear-flesh tubers and from .2 to 57 per cent from the plots planted with stem-end browning tubers. (See Table 3.) There was no significant difference in the amount of stem-end browning resulting from the use of the two different seed lots. In other words the amount of stem-end browning in the crop was practically the same on any given plot regardless of whether clear-flesh tubers or stem-end browning tubers were used as seed.

Additional tuber samples were collected from some of the permanent plots and stored at 36° F. until they were examined for stem-end browning. In these samples the amounts of stem-end browning were much lower. Roughly only about one tenth as much stem-end browning developed in comparable samples stored at 36° F. as developed at the 50° F. storage temperature.

Effect of rate of fertilizer application. Potatoes produced with no fertilizer developed very little stem-end browning as compared with potatoes produced with fertilizer. There was considerably more stem-end browning in tubers from plants grown with 2,000 pounds of 4-8-8 fertilizer than in the tubers grown with 1,500 pounds of the same type of fertilizer. Samples from plots receiving 2,500 and 3,000 pounds of 4-8-8 fertilizer showed no more stem-end browning than did those from the 2,000-pound plot. Last year (1941) the amount of stem-end browning increased with every increase in the rate of fertilizer used. (See Table 3.)

Effect of fertilizer ratio. In the nitrogen series where nitrogen was varied from 0 to 6 per cent while phosphoric acid and potash were kept constant, the tubers from the 0-8-8 plot showed only

about half as much stem-end browning as did the samples from the other plots. There was no appreciable difference in stem-end browning in the tubers from the 2-8-8, 4-8-8, and 6-8-8 plots. (See Table 3.)

In the phosphorus series the different rates of application of this element apparently had little or no effect upon the development of stem-end browning. (See Table 3.)

In the potash series the 4-8-0 plot produced tubers with very little stem-end browning. In the other plots of this series stem-end browning kept increasing with each additional amount of potash used. (See Table 3.)

These data on the effect of fertilizer ratio on stem-end browning are in general agreement with the data secured in 1941.

Effect of source of potash. Plots which received muriate of potash as a source of potash over a period of years produced tubers which developed about 24 per cent more stem-end browning than did comparable plots receiving sulfate of potash as a source of potash over a period of years. On the five half plots where sulfate of potash was substituted for muriate of potash for the first time in 1942 there was very little if any reduction in the amount of stem-end browning.

Chemically pure fertilizer mixtures. The seven plots which received fertilizer made up of chemically pure salts produced tubers in 1942 which developed about three fourths as much stem-end browning as comparable plots receiving the ordinary fertilizer. These data are somewhat in variance with previous data. In 1941 the tubers from these chemically pure fertilizer plots showed very little stem-end browning.

2. TEST PLOTS ON PRIVATE FARMS. *Effect of date of harvest on stem-end browning.* Three sets of tuber samples were harvested at each of five different dates from a uniform field of potatoes and stored under three different conditions. One set was stored at 36° F., another at 50° F. and a third at a variable temperature corresponding to the temperature of the soil during the harvesting period. In other words, soil temperatures were taken daily during the harvest period and the temperature of the storage bin was varied with the soil temperature. This meant that the storage temperature of this bin started at about 65° F. and was gradually lowered until it reached 36° F. It was then maintained at 36° F. for the remainder of the storage period. The samples stored at 36° F. for the

entire storage period developed considerably less stem-end browning than did the samples stored at 50° F. or at the soil temperature. There was very little difference in the amounts of stem-end browning developed at the two latter storage conditions. Stem-end browning tended to decrease with date of harvest, the percentages of stem-end browning in samples taken at the five harvest dates being 49, 36, 21, 16, and 11. (See Tables 4 and 5.)

Effect of source of potash in fertilizers. Four 5-8-12 fertilizers were compared, each with a different source of potash. One had all of its potash derived from muriate of potash, the second had half of its potash from muriate and the other half from sulfate of potash, the third had all of its potash derived from sulfate of potash, and the fourth had its potash derived from potassium metaphosphate and potassium nitrate.

Samples of tubers produced with these four fertilizers were secured on each of two farms. The samples were stored at 50° F. until examined for stem-end browning on March 1. There were no significant differences in the amounts of stem-end browning developed in tubers grown with these four sources of potash. (See Table 6.)

Effect of uncommon elements in potato fertilizers. Joseph A. Chucka, A. Frank Ross. The following chemical elements, barium, bismuth, cadmium, lithium, and strontium were added to different lots of 8-16-20 fertilizer. They were added in the form of chloride salts at the rate of 20 pounds of the salt per acre. Green Mountain potatoes were grown with these fertilizers on one farm. One barrel samples of tubers from each fertilizer were stored at 50° F. and later examined for stem-end browning. The tubers produced with the 8-16-20 containing cadmium developed the least stem-end browning but the difference as compared with the regular 8-16-20 was too small to be considered significant. (See Table 7.)

LATE BLIGHT CONTROL. Reiner Bonde. The early part of the growing season of 1942 was very favorable for the rapid spread of late blight, or "Rust," in Aroostook County. Late blight was found to be present in potato dump piles on June 8, which is the earliest calendar date at which the disease has been found under natural conditions in Maine. The disease was disseminated from infected dump piles to potato fields early in the season, and several fields were found to be infected the first and second week of July.

The spread of late blight from the infected dump piles occurred

before most farmers had begun to spray and the result was that some fields were badly blighted. A few fields were nearly destroyed by the disease and the loss in certain local areas was estimated at about 40 per cent of the crop. However, the spread of late blight was reasonably well controlled by an extensive spray program on the part of the farmers aided, no doubt, by weather conditions somewhat unfavorable for the development of this disease later in the growing season. As a result the total loss from late blight in Aroostook County was relatively slight in 1942. Furthermore, the harvesting season was favorable for obtaining the crop in good condition and the loss from late-blight tuber decay did not exceed one or two per cent of the crop.

Potato Refuse Piles and Late Blight Epidemics. Reiner Bonde, E. S. Schultz.[7] Studies were continued in 1942 to obtain additional information pertaining to the role played by the potato refuse pile in the spread of late blight. The information obtained supports the conclusion, based on data secured in other seasons, that the refuse pile is the most important factor contributing to the spread of late blight in Aroostook County. Some of the data secured in 1942 pertaining to the spread of late blight are summarized in Table 13.

Our available information pertaining to the potato refuse piles and the part they play in the dissemination of late blight have recently been summarized in Bulletin 416 of the Station.

Effect on the Yield of Potatoes and the Control of Late Blight as the Result of Reducing the Copper and Lime Content in Bordeaux Mixture. Reiner Bonde, H. R. Sheperd.[8] *With tractor-power spray outfit.* Metallic copper is an essential war commodity and the amount alloted by the Government for fungicidal purposes may be reduced in the near future. Additional information was secured in 1942 pertaining to the effect on yield and disease control of reducing the amount of copper and lime used for making Bordeaux mixture.

The data secured from experiments conducted in 1941 indicated that the formula for making Bordeaux may be reduced from

[7] Senior Plant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture.

[8] H. R. Sheperd assisted in conducting the spraying experiments during the season of 1942.

10-5-100 to 8-4-100 with no significant reduction in yield or the control of disease. During the season of 1942 the formula for making Bordeaux was reduced still more in an attempt to determine the lowest concentration at which this fungicide can be prepared and still give satisfactory control of the blight diseases. The experiments were conducted both with a tractor-power 3-nozzle per row spray outfit and with a 2-nozzle per row wheel traction-horse-drawn outfit.

Practically no late blight developed in the plots sprayed with 10-5-100 or with 8-4-100 Bordeaux and a trace of blight developed where a 6-3-100 Bordeaux was applied. Some infection occurred in those plots which were sprayed with 4-2-100 Bordeaux which was the weakest concentration under test. The spread of disease in these plots, however, was confined mostly to the low lying areas adjacent to the unsprayed check plots.

It was evident, from the data obtained, that a 4-2-100 Bordeaux, even when applied with a tractor spray machine was not concentrated enough to control late blight if weather conditions were favorable for the disease and the source of infection was heavy and close by. This low concentration of Bordeaux, however, gave fairly good control of the disease in the plots which were away from the heavy source of infection.

The yield data for the experiment in which the tractor outfit was used are summarized in Table 14. The yield of potatoes per acre was not reduced even when the 4-2-100 Bordeaux spray formula was used. The yield was not affected by reducing the amount of copper sulphate used for making Bordeaux from 126 pounds per acre to 50 pounds per acre when the material was applied with a tractor power spray outfit. This information would indicate that many potato growers who use tractor-power spray machines are now using much more Bordeaux than is necessary or even advisable.

With horse-drawn wheel-traction spray outfit. A similar experiment was conducted in 1942 using a 2-nozzle per row horse-drawn wheel-traction spray machine. This type of spray rig applied only 90 gallons of spray material per acre compared with approximately 140 gallons per acre applied with the tractor-power machine.

Late blight was controlled quite satisfactorily by all of the different Bordeaux formulae used in the experiment. In late Au-

gust and September some late blight appeared in the different plots. The amount of infection, however, was not serious and no large dead areas appeared. The unsprayed control was completely dead from late blight infection by August 14.

The data pertaining to this experiment have been summarized in Table 15. The 10-5-100 Bordeaux gave the best control of late blight. When the concentration was reduced to 8-4-100 the ability to control late blight was reduced and the "Protective Coefficient" was 0.90 compared with 1.0 for the 10-5-100 formula. The 6-3-100 Bordeaux had a Protective Coefficient of 0.83 and when the 4-2-100 formula was used the Protective Coefficient was reduced to 0.62.

Lowering the concentration of Bordeaux mixture resulted in a reduction in the yield rate of potatoes. (See Table 15.) The plots sprayed with 10-5-100 Bordeaux yielded 11 barrels or 30 bushels per acre more than did those sprayed with 8-4-100 Bordeaux. The other reduced concentrations gave a corresponding reduction in the yield rate.

It is probable, therefore, that the copper content in the Bordeaux used for spraying potatoes can be reduced materially if the applications are made with a tractor-power machine. However, if horse-drawn equipment with traction drive is used a reduction in the concentration of Bordeaux below the standard 10-5-100 formula may result in a slight lowering of the yield rate of potatoes.

Different Copper Fungicides Applied at Various Concentrations. Reiner Bonde, H. R. Sheperd. Four fungicides were compared with each other and with Bordeaux at four different concentrations of equal copper content. Copper Hydro Arsenate, a fungicidal-insecticidal material, was included at concentrations equal to ½ that of the other spray materials used in the different test plots. The results of these experiments have been summarized in Table 16. The highest yields from the four experiments were secured from the plots sprayed with Bordeaux and with Spray-cop. Spray-cop apparently was the most efficient of the neutral copper fungicides and in some cases was equal to Bordeaux in its ability to give increased yields. These data confirm those secured from previously conducted experiments that, in general, fields sprayed with Bordeaux will yield more than those sprayed with the neutral copper fungicides. In some cases Spray-cop has given yield results that were equal to those secured with Bordeaux and appears to be the

most efficient of the neutral copper materials that have been under observation at Aroostook Farm.

Reaction of Potato Varieties to Different Copper Fungicides. Reiner Bonde, H. R. Sheperd. Most of the potato spraying experiments that have been conducted in Maine have been done with the Green Mountain variety. Studies were begun in 1942 with other varieties to see if these react to the different spray fungicides in a similar manner as do the Green Mountains. Preliminary information indicates that the newer potato varieties react differently to the spray treatments than does the Green Mountain. The results suggest that the spraying recommendations issued to farmers should be different for the various varieties. This phase of the work should be continued before definite conclusions are reached.

Non-Copper Containing Spray Fungicides. Reiner Bonde, H. R. Sheperd. There has been some interest on the part of different chemical companies to develop a non-copper containing fungicide which can be used effectively for spraying potatoes. "Spergon,"[9] one of these new fungicides, was tested in 1942 regarding its ability to control late blight. The results of this test are summarized in Table 17.

"Spergon," at both concentrations tried, possessed considerable fungicidal value and controlled the disease early in the season. However, toward the end of the season this material failed to control the disease and the plants were killed and the yield of potatoes was reduced. It seems that this material lacks the ability to adhere to the foliage.

Copper Fungicides in Combination with Rotenone for the Control of Diseases and Insects. Reiner Bonde, Geddes W. Simpson. Studies were conducted regarding the compatibility of rotenone with the copper spray fungicides. It was considered desirable, also, to ascertain whether or not the addition of rotenone to the fungicide would be beneficial to the potato crop and be profitable for the growers.

Rotenone (4 pounds Derris root containing 4.8 per cent rotenone in 100 gallons of spray mixture) was used in combination with Cuprocide, Copper Hydro Arsenate and with Bordeaux mixture. The results of this experiment are summarized in Table 18.

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[9] Supplied through the courtesy of Naugatuck Chemical, Naugatuck, Conn.

The addition of rotenone resulted in an increase in the yield rate for all of the plots on which fungicides were used. It would seem that the rotenone was compatible with Bordeaux as well as with Cuprocide and Copper Hydro Arsenate. The addition of rotenone, however, did not reduce the amount of net necrosis or leafroll that resulted in the seed stocks.

PURPLE TOP. Reiner Bonde, Stanislas Snieszko. The organism or virus, whatever it may be, which causes purple top in potatoes is unknown at present although much has been done in an effort to identify the causal agency.

Some farmers and also seed certification inspectors have thought that purple top is caused by the presence of rhizoctonia infection on the stems and roots of the plant. Greenhouse and field studies show that the disease is not caused by the rhizoctonia fungus. The seed tubers from plants having purple top fail to grow or else produce only small fine sprouts and plants. The tubers from surviving plants infected with this disease produce normal plants when planted the following season. Symptoms similar to purple top may be caused by certain other fungi which attack the basal part of the plants. Plants so infected produce tubers which sprout and grow normally and therefore do not have the true purple top disease.

So far two methods have been found that may be helpful in reducing the losses caused by purple top. These are as follows: 1. Roguing all plants which have the disease will be helpful in reducing the number of weak plants or missing hills often encountered when infected seed stocks are planted. 2. The seed stock may be allowed to sprout slightly and those tubers which produce weak sprouts discarded for planting purposes. This may be a practical solution in some cases.

SEED DISINFECTION OF POTATOES. Elmer R. Tobey, Bernie E. Plummer, Jr., Reiner Bonde. Samples of acid mercuric chloride solution used in treatment of seed potatoes at Aroostook Farm were analyzed for acid and mercuric chloride strength. White distilled vinegar was used as a source of acetic acid in this experiment.

The acid and mercuric chloride strengths of potato seed disinfection solutions were determined for several potato growers.

White distilled vinegar, as a source of acetic acid, proved satisfactory in maintaining the mercuric chloride strength of dipping solutions used in the disinfection of seed potatoes.

POTATO FERTILIZERS

The proper use of fertilizer is a matter of considerable importance to the potato grower. Various amounts and kinds of fertilizers are under trial at Aroostook Farm and on privately owned farms with a view to obtaining new facts relative to this phase of production methods.

PERMANENT PLOTS. Joseph A. Chucka, Arthur Hawkins, Elmer R. Tobey, Bernie E. Plummer, Jr. The yield data from the permanent plots have been summarized for the years 1927-1941 and published as Station Bulletin No. 414. Copies of this bulletin may be secured upon request. The 1942 potato yields from the permanent plots are in general agreement with those secured in previous years. One additional fertilizer treatment was added to those formerly used. This treatment consists of 2,000 pounds per acre of a 4-8-8 fertilizer in which all of the nitrogen is derived from sulfate of ammonia with sufficient lime (calcium carbonate) added to neutralize the equivalent acidity developed by the sulfate of ammonia. During the first year of its use this fertilizer produced three more barrels per acre than a comparable fertilizer which did not contain the lime.

FERTILIZER RATIO.[10] Joseph A. Chucka, Arthur Hawkins, Bailey E. Brown, Elmer R. Tobey, Bernie E. Plummer, Jr. Fertilizer grades varying in percentages of nitrogen, phosphoric acid, and potash were compared on five farms in Aroostook County and on two farms in central Maine. Green Mountain, Katahdin, Sebago, and Chippewa varieties of potatoes were grown on these test plots. The yields varied considerably from farm to farm and with the different varieties but the highest average yields were secured where the treatment consisted of a ton per acre of a 6-8-12 fertilizer.

HI-LO FERTILIZER PLACEMENT. Joseph A. Chucka, Arthur Hawkins. The standard band placement of fertilizer was again compared with the so-called Hi-Lo placement for potatoes at Aroostook Farm. The Hi-Lo placement consists of placing one fertilizer band to the side and just slightly below the seed piece with the other fertilizer band on the opposite side two or three inches below the seed piece. For the third season no significant difference in yield was secured between the two placements.

[10] Cooperative with Bureau Plant Industry. Bailey E. Brown is the Bureau representative on this study.

POTASH SOURCE.[10] Joseph A. Chucka, Arthur Hawkins, Bailey E. Brown. Four different sources of potash in fertilizers of a 5-8-12 grade were compared on two farms in Aroostook County in 1942. The sources of potash used were muriate of potash, sulfate of potash, nitrate of potash, and potassium metaphosphate. Three varieties (Green Mountain, Chippewa, and Sebago) of potatoes were grown on each of the two farms. No significant difference in yield of potatoes was secured with the fertilizers having the different sources of potash. The fertilizer containing muriate as a source of potash produced potatoes with a lower starch content and a somewhat inferior cooking quality.

PHOSPHORUS SOURCE.[10] Joseph A. Chucka, Arthur Hawkins, Bailey E. Brown. Superphosphates made with "spent" and "sludge" sulfuric acids were compared with regular superphosphate as a source of phosphoric acid in potato fertilizers on two farms in Aroostook County. No significant differences in yield of potatoes were secured with the fertilizers containing the three different superphosphates.

SEED SPACING AND VARIETIES. Joseph A. Chucka, Arthur Hawkins. The comparison of the yielding ability of eight varieties of potatoes at three different seed spacings and at three levels of fertilizer applications was repeated in 1942. The seed spacings used were 6, 9, and 12 inches. The rates of fertilizer application were 1,000, 1,250, and 1,500 pounds per acre of an 8-16-20 fertilizer. The test was conducted on Aroostook Farm, Presque Isle, and on the Smith Farm at Stillwater.

Considering the yields produced as an average of the three spacings and an average of the three rates of fertilizer applied, the range in field-run yields for the eight varieties at Presque Isle was 182 to 129 barrels per acre. The rank of the varieties in descending order was Houma, Chippewa, Green Mountain, Sebago, Katahdin, Earlaine #2, Warba, and Irish Cobbler. On the same basis the yield range of the eight varieties at Stillwater was from 119 to 75 barrels per acre and the rank of the varieties in descending order was Houma, Earlaine #2, Chippewa, Green Mountain, Sebago, Irish Cobbler, Katahdin, and Warba. It is of interest to note that Houma produced the highest yield of the eight varieties at both locations in 1942 which is relatively much better than it yielded during the two previous years.

The yield of each variety tended to increase with closer spac-

ing and with each increase in the amount of fertilizer applied. The average size of tubers produced tended to decrease with closer spacing. These tendencies were less evident at Stillwater where the total yields were rather low and they were definite at Presque Isle where the total yields were higher.

POTATO PRODUCTS

The principal interest in potato products has been in connection with potato starch and its established and possible uses, its improvement, the use of the pomace from starch factories, and dehydrated potatoes.

GLUCOSE. Charles A. Brautlecht. Last fall an official of a large syrup company was interested in the possibility of obtaining some potato starch for manufacture of glucose. A canvass of starch available in Maine was made, and statements as to prices and quality were submitted. This led to further laboratory and commercial tests. Many carloads of Maine potato starch, for the first time in history, were converted into glucose for blending syrups. It was bought on a "toll" charge by users of the syrups in order not to disturb established marketing channels. Even poor grades of Maine starch that normally would not readily be marketed were satisfactorily used.

STARCH FACTORY POTATOES. Charles A. Brautlecht. Sixteen samples of potatoes from starch factory hoppers were examined. Practically all varieties and conditions of potatoes were represented. Starch content for the season, for the sixteen samples, was as follows:

STARCH CONTENT		NO. TO FIVE KILOGRAMS (11 LBS.)
Av. 12.6		47
Max. 14.1 (Green Mountains)	No. (smallest size)	95
Min. 10.5 (Katahdins and some Chippewas)		29

There were practically no sound potatoes of 2 inch to 4 inch size. In some samples there were many small sound potatoes. Digger cuts were very common and many samples had much sunburn. In some samples there were a few "giants," growth cracks, insect and worm injury, spindle tubers and second growths. Diseases

most commonly met were scab and rhizoctonia (which are not important in starch production), a little silver scurf, net necrosis, chilling injury, late blight, stem-end browning, wilt or bacterial ring rot, a few unidentified diseases, and late blight storage rot.

The average starch content of factory hopper potatoes, 1942 crop, was 11.5 per cent. The slightly higher starch content, compared to the previous year, was probably due to a decrease in Chippewas and a slight increase in Green Mountains, Sebagos, and Houmas delivered to starch factories.

COMMERCIAL POTATO STARCH. Charles A. Brautlecht. Twenty-eight samples of commercial potato starch were examined with results as follows:

	AVERAGE	MAXIMUM	MINIMUM
Moisture %	17.7	22.5	10.7
Total solids by difference %	82.3	77.5	89.3
Ash %	0.25	0.38	0.14
Viscosity, centipoises for 1% soln. in 0.6% NaOH	5.1	9.3	3.3
Granule size	30	22	35
Acid, quantity (cc. of 0.1 N NaOH per 25 g.)	2.6	6.8	1.6
Speck count, macro, 5 g. per dcm.	525	1825	40
Sieve test (on powdered samples) finer than 200 mesh %	98.4	99.4	94.8
Bacteria (B. coli) 9 samples	6 positive	4/5 in 0.1 g	—
	3 negative	—	—
Reflectance (whiteness) %	90.3	99.0	84.1
pH (degree of acid)	6.6	7.1	6.0
Solubles	0.13	0.29	0.05

As in the past few years, the better grade potato starch has shown negative in tests for fat, fiber, protein, or nitrogen. The poorest quality of starches usually show small quantities of these substances.

POTATO SUPPLY FOR STARCH FACTORIES. Charles A. Brautlecht. With a very good starch market, many manufacturers endeavored to get into operation about September 15th. There was no diversion program or subsidy on the 1942 crop. The potato market had all indications of becoming stronger and growers and shippers held back on culls or pickouts. Thus the supply to the starch factories was small with a limited supply of raw material. With difficulties

to obtain labor and to keep it under a war economy while operating under the rigid governmental ceiling price for starch, some factories did not open or could not remain open long.

STARCH MARKET AND PRICE. Charles A. Brautlecht. The starch market was very strong. Manioc (cassava, tapioca) was imported only in very small quantity. Its use is now limited by government regulation. Much corn starch was shipped abroad on lend-lease account. The price established as a ceiling on domestic potato starch in cents per pound remained practically at 6.37 for car lots in New York and 7.60 for less than car lots. Boston rate is practically the same. Potato dextrin price remained at 10 cents per pound for car lots and at 10.25 to 11.75 cents for less than car lots.

EXPERIMENTAL POTATOES. Charles A. Brautlecht. Samples of potatoes from fertilizer studies were examined for total solids and starch with results indicated in Table 19. The Green Mountain variety contained the greatest amount of starch, as usual, but the source of potash other than muriate had little effect on the starch content of this variety. In the Sebago variety the higher starch percentages were obtained in the plots receiving potash from potassium sulfate or from potassium metaphosphate and potassium nitrate.

Foreign and domestic potatoes grown in yield tests, conducted by Mr. Robert V. Akeley at Presque Isle, were examined for starch content and size. The yields were computed by Mr. Akeley. These potatoes compared with the same varieties grown in 1941 showed a falling off in starch content and yields, in both domestic and foreign varieties. (See Table 20.)

POTATO DYHYDRATION. Charles A. Brautlecht. About a year ago the first interest in potato dehydration on the part of possible dehydrators arose in Maine. Previous to that time, some letters had been received and some interviews had been held regarding such activity which developed no actual operations. With the growing interest on the part of our government in dehydrated potatoes for our armed forces in foreign lands and for lend-lease, potato dehydration was carried out on a larger scale in the older dehydration plants in Idaho and in the Pacific Coast States, and in British Columbia. As Maine was the largest potato-growing State, it began to receive increased attention.

In Maine, there are now six potato dehydration plants (Hartland, Winterport, Fort Kent, Washburn, Fort Fairfield, and West-

field) in operation with a total capacity of about 23 tons of the dehydrated product per day, using about 200 tons of potatoes daily. Three plants began operation in December and two others in April. Another plant at Boothbay Harbor has been equipped for hot fat dehydration (canned chips and shoestrings) and has had trial runs. One starch factory organization in Caribou is preparing for partial conversion of existing facilities and expects to be in operation next fall. The waste from four of the above listed dehydration plants will probably be worked up for its starch content. With mechanical peeling, from 15 to 30 per cent of the potatoes may represent waste. Therefore, with a good starch market, an affiliated starch factory in operation can economically handle such waste.

Potato dehydration has been carried out in Germany and in other parts of Europe for over a hundred years. Drying, in ancient times, was the only common means of food preservation. In normal times, a few years ago, a few hundred potato flake factories in Germany made excellent cattle feed products. A considerable quantity was made also for human food. During war times food preservation takes on added importance, everywhere. Dehydration has advantages in shipping and storing. Flakes, slices or pieces (strips or dice) are prepared by peeling and cutting, are then blanched to destroy oxidases, and dried, cooked, extruded and dried, or mashed against steam heated rotating drums, and then dried. Tunnel dryers, parallel, counter current and parallel-counter current or central exhaust air flow represent the lowest cost in fixed capital investment for the drying operation. Mechanical dryers of the two belt variable speed type with controlled air flow are in use. In Maine there are now parallel, counter flow, and combination air-flow tunnels, belt, rotary, and compartment dryers, and potato chip machines. Cabinet dryers are used, especially with smaller tonnages and a greater variety of products. The tunnel dryer with tray trucks is extensively used in dehydration, especially as tunnels can be used for parallel, counter flow or a combination parallel-counter flow operation. In addition there are few wearing parts. Tunnel dryers are also easily adapted to more than one product.

Almost all of the dehydrated potatoes are being made under Army or Lend-Lease contract, being disposed of by Army, Navy, Marine or Lend-Lease officials. Specifications are not easy to meet and much care in preparation and drying is needed. Moisture content, absence of peroxidases, defect tolerance as to fine material,

scorched pieces, specks, decayed or bruised material, as well as color and aroma characteristics are specified. The rehydrated or reconstituted material must be like to the material before drying in form, color, and texture. Packaging must conform to specifications and represents a high cost per pound for material consisting usually of tins or of cubic foot paper board package, this placed in treated lead-foil lined kraft paper bag, this heat sealed, placed in a second paperboard (fiber) box and two of these boxes packed in a wooden box with strap iron or wire bands for export shipment. The Agricultural Marketing Administration is the inspecting agency for the Army and Lend-Lease and maintains many laboratories, one in Maine for the States of Maine, New Hampshire, and Vermont in which various foods for government contract are tested as to grade and specification. There is also, at present, a civilian market for dehydrated foods, which fail to meet the Army specifications for some comparatively minor reason.

Several samples of potatoes from Maine and New Brunswick dehydration factories have been examined by variety for total solids and starch content. Green Mountains and Katahdins are used almost exclusively. Total solids and starch were as follows:

		GREEN MOUNTAINS	KATAHDINS
Total Solids	Av.	23.3	19.3
	Max.	25.4	20.0
	Min.	21.0	17.5
Starch	Av.	15.4	12.0
	Max.	17.2	12.5
	Min.	14.3	11.0
Potatoes to 5	Av. No.	27	29
kilograms (11 lbs.)	Max. No. (small size)	30	36
	Min. No. (largest size)	18	23

Close grading before washing and mechanical peeling in potato dehydration plants greatly reduces peeling losses as small potatoes are ground to pieces before large ones are peeled. There is much interest at present in steam, lye and flame peeling of white (Irish) potatoes. Steam and mechanical peeling will be done in Maine during the next season.

The quality of potatoes going into dehydration plants, as a rule,

has been very good. Katahdins were most extensively used, due to their round shape which reduces peeling loss and due to no lots having net necrosis or stem-end browning defects, which cause increased waste and higher picking table costs.

ECONOMICS OF THE POTATO INDUSTRY

PRACTICES AND PRODUCTION COSTS IN AROOSTOOK COUNTY. William E. Schrumpf. Information was obtained regarding the practices of growers and their costs for the various items in potato production on 178 farms in central Aroostook County in 1940 and on 172 farms in southern Aroostook County in 1941. The central area includes the towns beginning with New Sweden in the north and ending with Mars Hill in the south. The southern area includes Aroostook County towns south of Mars Hill.

In Central Aroostook the average size of farm was 192 acres of which 119 acres was crop land. The potato acreage per farm ranged from 10 acres to 300 acres, the average being 47 acres. Although 12 varieties of potatoes were grown, the four varieties Green Mountain, Katahdin, Irish Cobbler, and Chippewa, made up about 96 per cent of the total potato acreage. The average yield rate of potatoes was 124 barrels per acre. The most important livestock was dairy animals which made up about two thirds of the animal units. Dairy animals averaged five per farm and were kept on 98 per cent of the farms. The most common tractive-power unit was made up of two horses, one general-purpose tractor, and one truck. This size unit, on the average, cared for 45 acres of potatoes. Of the total farms 14 per cent operated without horses. The tractive-power unit composed of one general-purpose tractor and one truck averaged 40 acres of potatoes, and a unit composed of two general-purpose tractors and one truck 74 acres of potatoes.

Of the potatoes produced, 7 per cent were sold from the field, 42 per cent were placed in track storage, and 51 per cent in farm storage. The average cost to the farmer for producing potatoes including growing, harvesting, storing, and selling averaged $1.13 per barrel. Because of the increased cost of labor and materials the cost in 1943 will average approximately $1.50 per barrel. In producing an acre of potatoes 79 hours of man labor, 33 hours of horse labor, 7 hours of tractor use, and 9 hours of truck use were

expended on the average. Of the total potato acreage, 64 per cent was planted with certified seed. The average planting of seed per acre was 7.8 barrels. The fertilizer application averaged 0.8 ton per acre. Of the total fertilizer 71 per cent was comprised in the four formulas, 5-8-12, 5-8-10, 8-16-20, and 8-16-14. Barnyard manure was applied to 18 per cent of the potato acreage and green-manure crops were turned under on 23 per cent. Potato vines received six applications of fungicides. Home-made Bordeaux mixture applied in a wet spray was used on 82 per cent of the potato acreage, other wet sprays on 9 per cent, and copper-lime dust on 9 per cent. The cost of materials, labor, and equipment in spraying totaled \$1.79 per acre and in dusting \$1.85 per acre. On the average, work on potatoes was done more quickly and cheaply with tractors than with horses. In plowing, for example, one man and two horses on the average plowed an acre in 7 hours at a cost for man, horses, and equipment of \$5.36. In comparison, one man and one tractor plowed an acre in 2.5 hours at a cost for man, tractor, and equipment of \$3.37. In general, one man and one tractor accomplished twice as much work in a day as one man and two horses at about two thirds of the cost.

In southern Aroostook the farms averaged 171 acres in area of which 84 acres were in crops. On the average each farm had 25 acres of potatoes. The farm acreage ranged from 50 acres to 600 acres and the potato acreage from 10 acres to 140 acres. Nine varieties of potatoes were represented on these 172 farms. The two varieties, Katahdin and Green Mountain, were the most popular and accounted for nearly four fifths of the total potato acreage. The average yield rate of potatoes was 109 barrels per acre. Livestock kept on the farms was composed largely of dairy animals and there was an average of 7 animals per farm. Dairy animals made up about two thirds of the total animal units. There were 372 horses, 108 tractors, and 123 trucks on these 172 farms. The average age of the horses was 10 years, of tractors 8 years, and of the trucks 7 years.

SOME TRANSPORTATION AND ALLIED PROBLEMS ASSOCIATED WITH THE MARKETING OF MAINE POTATOES UNDER THE WARTIME EMERGENCY. Charles H. Merchant. Under wartime conditions it seemed advisable to obtain information on where potatoes are stored and the condition of transportation facilities for the efficient handling of the crop. Such information may be helpful to potato growers

and shippers and to government agencies in conserving vital transportation equipment and in the allocation of trucks and tires.

Much of the material for the study was obtained by high school students working under the supervision of their teachers. These students obtained information from 323 potato growers who produced 8 per cent of the 1942 potato crop.

Slightly over 50 per cent of the 1942 potato crop was placed in farm storage, 44 per cent was placed in storage houses with track facilities, 2 per cent was placed in other storage facilities not on the farm or on railroad sidings, and 4 per cent of the potatoes were shipped to market at the time of harvest. This study showed that more detailed information on storage facilities is needed especially if an acute shortage appears in truck transportation or if the size of the potato crop is materially increased.

The average estimated distance from the potato fields to farm storages on the 262 farms reporting was .9 of a mile. This was the distance one way and several stops were made in collecting a load of potatoes. Also, some distance was covered in making turns in the field and at the farm storage house. When trucks were in use the motor usually idled at stops for loading the potatoes and frequently at the potato storage house when potatoes were unloaded. Thus, the average round trip was equivalent to about three times the distance one way or about three miles per trip so far as gasoline consumption is concerned.

The average estimated distance from the field to track storage on the 174 farms reporting was 4.8 miles. The distances varied from 3.8 miles on farms in central Aroostook County to 12.1 miles on farms in central Maine. The average distance of a round trip for farmers in all areas would be about 12 to 14 miles.

Distances from field to other storage facilities ranged from 1.2 miles on farms in central Aroostook to 3.4 miles on farms in central Maine. The average one-way distance on the 27 farms reporting was 2.5 miles per farm or about 6 to 8 miles per trip.

The average distances from farm storage to railroad sidings for the 253 farms reporting was 4.3 miles or nearly 9 miles per trip. The average one-way distance varied from 3.1 in central Aroostook to 8.6 in central Maine.

Farmers indicated that 49 per cent of the truck mileage was used for hauling their potatoes; 12 per cent was used for hauling fertilizer, lime, and seed; 7 per cent was used for hauling water,

spray, and dust materials; 5 per cent was used for hauling potatoes for other farmers; and 27 per cent was for uses other than the potato enterprise.

There was considerable variation in the use of trucks in the four potato areas. Nearly 58 per cent of the truck mileage in central Aroostook was for hauling potatoes as contrasted to less than 35 per cent in central Maine. About one fifth of the mileage of trucks in central Aroostook was used for purposes other than the potato enterprise as compared with 46 per cent in central Maine. Slightly less than one third of the truck mileage in northern and southern Aroostook was for purposes other than the potato enterprise.

Nearly 50 per cent of the trucks included in the study had been driven less than 40 thousand miles. It seems reasonable to expect that most of these trucks will be serviceable in 1943 with only minor repairs. Trucks driven 40 thousand to 80 thousand miles comprised about 45 per cent of all trucks. Many of these trucks will need extensive repairs and in some instances replacements will be necessary. About 5 per cent of the trucks had over 80 thousand miles and in general were in poor condition. Most of these trucks will need to be replaced if essential to the war effort. On the basis of total mileage of the trucks included in the study and assuming trucks will last about ten years, it will require about 320 trucks for replacements during 1943.

With an average mileage of 7,000 miles per farm truck it is estimated that about 9,000 truck tires will be needed to maintain all farm trucks in Maine potato areas during 1943. Based on 9.1 miles per gallon of gasoline (average for farmers' trucks included in the study) it will require nearly 2.5 million gallons of gasoline to maintain the 3,200 farmers' trucks with an average mileage of 7,000 miles each.

Nearly three fourths of the farmers included in the study operated one or more tractors. Largely on the basis of the general condition of the tractors along with the age of tractors it is estimated that about 300 tractors will need to be replaced during 1943 to maintain the present motive power on potato farms. Tractor tire replacements will be needed for the front wheels of about 810 tractors and for the rear wheels of about 620 tractors to keep them in serviceable condition during 1943. Based on the average fuel consumption of tractors it would require about 2.16 million gallons of

gasoline to operate the estimated 2,700 tractors for an average period of about 40 days.

The potato enterprise has peak periods for trucks and tractors during planting and harvesting which make it extremely difficult for farmers to pool or share farm equipment. Due to the relatively short growing season (usually 90 to 110 days) the potato crop in Maine is planted in the spring as soon as the ground can be worked and the potatoes are all harvested by the middle of October to avoid freezing the crop in the ground. During the peak periods trucks and tractors are frequently operated 16 to 24 hours per day. In some cases farmers have found it profitable to own equipment which is operated only during these critical periods. Probably horses cannot be used to materially relieve tractors and trucks during the emergency due to the small number of horses, age of horses, availability of horse-drawn equipment, and the additional time needed to perform the operations by horses.

The detail data of this study are published in Maine Agricultural Experiment Station Miscellaneous Publication 572 under the title, "A Study of the Farmers' Transportation and Storage of Potatoes in Maine Under Wartime Conditions."

MACHINERY

There is an increasing interest in the problem of soil erosion. The employment of erosion control practices such as terracing, contour planting, etc., presents a special problem from the standpoint of field machinery such as planters, sprayers, horse hoes, and diggers. The Maine Station and the Research Division of the Soil Conservation Service of the U. S. Department of Agriculture are cooperating in a study of erosion control and the development of machinery suitable for use on cross-slope planting. The machinery problems are under the immediate supervision of Mr. John W. Slosser of the Soil Conservation Service.

POTATO PLANTER. John W. Slosser. The first important machine to be used in the potato growing season is the planter. A machine has been developed which permits planting on slopes up to 15 per cent or greater without side slippage. This planter, also, is designed to insure accurate and uniform placement of seed and fertilizer regardless of surface configuration. The completed plant-

er is reduced in weight somewhat and is less subject to breakage caused by field stones and other hidden obstructions in the soil. (See Fig. 2.)

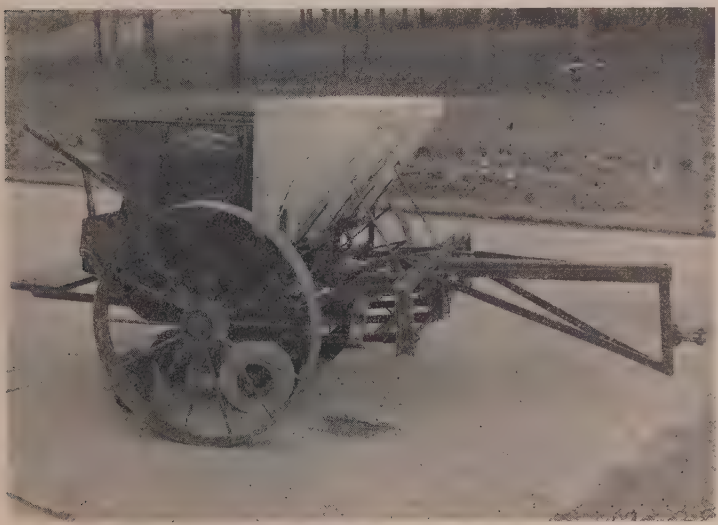

FIG. 2. Completed potato planter after all revisions have been applied, including reversed fertilizer boxes and drag bars.

POTATO DIGGER. John W. Slosser. Difficulties have been experienced in digging potatoes in fields planted on the contour. All of these difficulties have been overcome in the new experimental digger. This new machine has accurate automatic and positive depth control. The bed can be manually adjusted to operate on the level. Under normal operation this would require an adjustment at the end of the row when the operator makes the turn. The digger has a floating tail section designed for the purpose of reducing tuber damage. (See Figs. 3 and 4.)

OTHER MACHINERY. John W. Slosser. The developments in the planter and digger designs mentioned above enable operation of these machines on slopes formerly thought to be too steep or irregular for cross-slope cultivation and thus extend the area that can be protected by terraces and interceptions and used for clean tilled

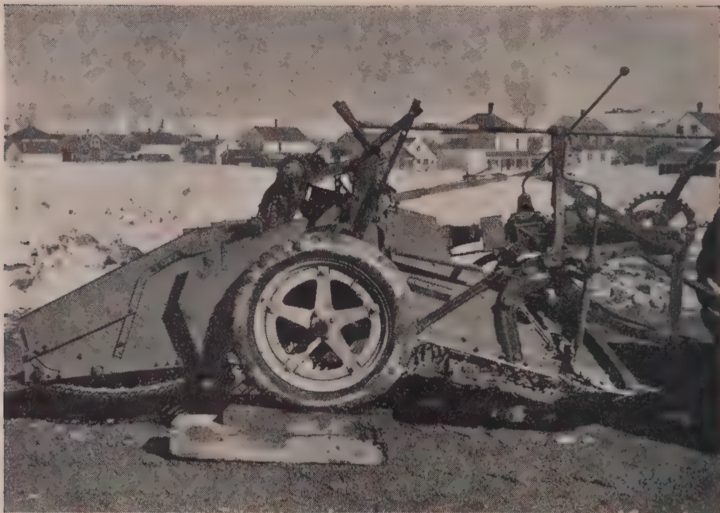

FIG. 3. Right side view of altered one-row power digger. Note provisions for leveling bed and angling cutting blade. This digger operated very successfully on side slopes to 18 per cent.

potatoes. There are other important machines, however, used in potato growing and these are being given attention. Definite progress has been made on sprayers, cultivators, hoes, etc. A method of spray mixing has been devised using an ordinary centrifugal pump for mixing and loading. Preliminary work has been done on early harvest by mechanical removal of the potato vines. This will be of particular interest to the growers of foundation and certified seed in their program for the control of leafroll. It is conceivable, however, that a general practice of early harvesting for seed purposes might develop were the means available for performing this operation at a low cost.

The problem of machinery for cross-slope use was responsible to a large extent for the initiation of these studies on the various machines. Many of the developments, however, are applicable as improvements to machines used on level land.

FIG. 4. Rear view of digger shown in Figure 3. Right wheel is blocked to simulate slope. Note that bed is nearly level.

STATION PUBLICATIONS OF INTEREST TO POTATO GROWERS

BULLETINS

421. Rate of Spread and Effect on Yield of Potato Virus Diseases.
418. Farm Credit in Aroostook County, Maine.
416. Potato Refuse Piles as a Factor in the Dissemination of Late Blight.
414. Potato Fertilizer-Rotation Studies on Aroostook Farm 1927-1941.
413. A Study of Land Use in Thirty-one Towns in Aroostook County, Maine.
410. Potato Virus Disease Studies with Tuber-Line Seed Plots and Insects in Maine 1927 to 1938.
407. Results of Testing Some Laboratory Methods for Possible Use in the Detection of Virus Diseases in Potato Tubers.
406. Farm Organization and Costs and Returns in Producing Potatoes on Farms in the St. John River Area of Aroostook County, Maine, 1937.
403. Aphids and Their Relation to the Field Transmission of Potato Virus Diseases in Northeastern Maine.
396. Bacterial Wilt and Soft Rot of the Potato in Maine.

MISCELLANEOUS PUBLICATIONS

572. Transportation and Storage of Potatoes in Maine under Wartime Conditions.
563. Marketing Maine Potatoes. A Preliminary Report on Interregional Competition of Maine Potatoes on the Boston Market.
561. Marketing Maine Potatoes. I. A Preliminary Report of Consumer Preference for Potatoes in Boston, March 4 to April 6, 1940.

ABSTRACTS OF ARTICLES PUBLISHED IN PERIODICALS

RING ROT IN VOLUNTEER PLANTS[11]

Bacterial ring rot, observed in 1932 for the first time so far as Maine is concerned, has been tested nearly every year since then for its ability to overwinter in the soil and infect a crop planted on the same area the following season. In no case has the disease been carried over the winter in the soil except as a disease of surviving tubers producing volunteer plants. This was true even when diseased material was thoroughly mixed with soil in hollow tiles which were covered with straw mulch for protection against cold. Diseased tubers that become frozen are not a source of danger, while winter-surviving diseased tubers are dangerous even when the grower hopefully uses the land for planting seed stock free of ring rot.

RESISTANCE OF CERTAIN POTATO VARIETIES AND SEEDLING PROGENIES TO RING ROT[12]

Ring Rot, caused by *Phytomonas sepedonica,* has become a major potato disease of the United States and Canada since its discovery in Quebec in 1931. The chief control methods now recommended, namely, the planting of disease-free seed and the use of sanitary mehods to avoid contamination, are often difficult to follow effectively. A search for resistant or immune varieties, including

[11] This is an abstract of a paper by Reiner Bonde, having the same title and published in Amer. Potato Jour. 19: 131-133. 1942.

[12] This is an abstract of a paper by Reiner Bonde *et al.,* having the same title and published in Phytopathology *32*: 813-819. 1942.

new seedling varieties, has been initiated, using certain methods of inoculation. It was shown that varieties range from some that are very susceptible to others that are quite resistant. Two European varieties, Friso and President, were found to be resistant and five unnamed seedlings were apparently immune.

VIRUS LEAFROLL RESISTANCE IN THE POTATO[13]

Leafroll is a virus disease that has symptoms fairly constant in different varieties, that reduces the yield rate, that causes net necrosis in some varieties, that is spread by aphids, and that in recent years has become more difficult to control in Maine. European, South American, and American potato varieties that had been found to be resistant to leafroll have been used as parents in making crosses. Thousands of seedlings from these crosses have been tested for resistance by the tuber-graft method and by the field-exposure test at Beltsville, Maryland, and at Aroostook Farm, and by the field-exposure test at Highmoor Farm, where this test is rigorous. The parent varieties and the seedlings have shown varying degrees of resistance to leafroll and some have shown no net necrosis even when contracting leafroll.

TUBER-LINE SEED PLOTS[14]

Starting with single tubers, their progeny could sometimes be increased as tuber-lines up to an acre before they became infected by virus diseases brought by insects from other fields. They could be kept healthy indefinitely under aster cages. Aster-cage tuber-line foundation-stock was distributed to 74 Maine farmers who planted it in 114 seed plots from 1933 to 1938. The plots were examined and rogued and the progeny was examined the next year to disclose what had happened to the disease content of the tuber-line stock in the seed plot. The results showed that seed plots usually have some virus disease brought in from outside. Seed

[13] This is an abstract of a paper by F. J. Stevenson, Donald Folsom, and T. P. Dykstra, having the same title and published in Amer. Potato Jour, 20: 1-10. 1943.

[14] This is an abstract of a paper by Donald Folsom, having the same title and published in Amer. Potato Jour. 19: 225-229. 1942.

plots usually were more successful, as to mosaic control, as they were located closer to the southwest corner of the State, and were more successful as to leafroll control as they were located closer to the northeast corner. Success in controlling virus disease in a seed plot usually was greater as the plot was earlier in planting and in the development of the plants, as the area of the plot was greater, and as the isolation from other fields was better. Tuber-unit planting permitted more complete roguing out of diseased hills but too often was associated with poor location, late planting, small size, and poor isolation; these factors apparently were more important than the method of planting in determining the success of the seed plot.

SAMPLE SIZE AND RELIABILITY[15]

If a sample of a potato seed stock is to represent the seed stock reliably, the sample must include about 7,369 tubers at a reading of from 1.50 to 2.50 per cent, about 33,839 at a reading of from 9.50 to 10.50 per cent, and about 338 tubers at a reading of from 5.00 to 15.00 per cent. Intervening numbers are tabulated for other percentages and ranges. Derivation and verification according to standard formulae are illustrated.

[15] This is an abstract of a paper by Donald Folsom, having the same title and published in Amer. Potato Jour. 19: 197-199. 1942.

APPENDIX

TABLE 1

Net Necrosis and Stem-End Browning Development at Time of Digging and at Different Storage Temperatures. 1942-43

Storage conditions	Per cent SEB[1] and NN[2]									
	Series 100		Series 200		Series 300			Series 400	
	SEB	NN	SEB	NN	SEB	NN	NN inc.[3]	SEB	NN
At digging	0	0	0.37	0	0	11.9	—	—	.27
90 days at 31° F.	.57	0	1.1	0	1.4	15.3	3.4	.7	.41
90 days at 33° F.	.72	0	1.3	0	1.5	17.1	5.2	.7	.56
91 days at 36° F.	1.7	0	1.6	0	1.5	20.0	8.1	.4	.68
30 days at 31° F., 61-63 days at 51° F.	1.7	0	.74	.12	1.1	16.4	4.5	1.1	2.5
30 days at 33° F., 62-63 days at 51° F.	2.0	0	.62	0	2.5	21.3	9.4	1.5	5.0
30 days at 36-37° F., 62-63 days at 51° F.	2.9	.29	2.1	0	3.6	30.2	18.3	2.7	7.7
61-62 days at 51-53° F.	16.2	.28	30.6	.24	5.2	29.7	17.8	11.1	15.8
91 days at 51-53° F.	21.7	.43	39.5	.12	6.4	36.2	24.3	15.9	15.0
60 days at 70-71° F., 32-34 days at 50-51° F.	1.0	.14	.85	0	2.1	12.2	0.3	1.8	1.9
31-32 days at 53-55° F.	8.2	.44	23.3	0	4.8	22.7	10.8	5.1	9.4

[1] SEB = Stem-end browning.
[2] NN = Net necrosis.
[3] Increase over per cent at digging.

TABLE 2

Yield of Potatoes in Leafroll Experiment
Houlton, Maine, 1942
(Derris sprayed and dusted plots)

Farm	Barrels per acre					Per cent increase or decrease
	Dusted plot	Dusted check	Sprayed plot	Sprayed check	Increase or decrease	
Number 1	154	114.5			+39.5	+35.0
Number 2	130.5	104.5			+26	+25.0
Number 3	199			135	+64	+47.5
Number 4			152	135	+17	+12.5
Number 5	210			179	+31	+17.0
Number 6			196	179	+17	+ 9.5
Number 7			187	186	+ 1	+ .5
Number 8			146.5	156.2	— 9.7	— 6.0

TABLE 3

Stem-End Browning and Net Necrosis Readings on Potato Samples from Permanent Soil Fertility Plots, 1942
Samples stored at 50° F.

Treatment	A – Clear flesh seed[1]		B – Stem-end browning seed[1]		Average	
	% SEB[2]	% NN[3]	% SEB	% NN	% SEB	% NN
Rate of Application						
No fertilizer	3	2	4	4	3	3
1500 lbs.	24	12	28	11	26	12
2000 lbs.	37	14	38	15	37	15
2500 lbs.	33	22	34	22	34	22
3000 lbs.	26	26	38	24	31	25
Fertilizer Ratios						
0-8-8	15	8	17	9	16	8
2-8-8	32	16	34	17	33	17
4-8-8	37	14	38	15	37	15
6-8-8	30	26	34	22	32	24
4-0-8	27	7	32	13	29	10
4-4-8	33	14	39	21	36	17
4-8-8	37	14	38	15	37	15
4-12-8	35	26	23	26	29	26
4-8-0	2	4	0.2	4	1	4
4-8-4	11	13	13	17	12	15
4-8-8	37	14	38	15	37	15
4-8-10	32	19	37	17	35	18
4-8-12	46	9	41	22	44	15
Source of Nitrogen						
Nitrate of soda	38	16	38	18	38	16
Sulfate of ammonia	36	11	38	7	36	9
Urea	31	10	30	11	30	11
Fish meal	34	17	35	15	34	17
Cyanamid	29	14	22	14	23	14
½ NO_3–½ NH_3	26	16	24	19	25	17
⅜ NO_3–⅜ NH_3–¼ ORG.	37	14	38	15	37	15
¼ NO_3–¼ NH_3–½ ORG.	32	19	38	16	35	17
Chemically Pure Salts						
80 lbs. of N, 160 lbs. of P_2O_5, and 160 lbs. of K_2O from chemically pure salts (mono-ammonium phosphate, potassium nitrate, and urea)	24	9	20	9	22	9
	21	6	22	5	21	6
	17	6	23	7	20	6
	21	5	16	3	19	4
	18	6	17	4	18	5
	20	4	16	4	18	4
	17	6	19	2	18	4
Acid versus Neutral Fertilizers						
Acid mixtures	28	19	31	18	30	18
Acid mixture plus Kieserite	38	13	32	24	35	18
Acid mixture plus Dolomite	41	23	30	19	36	21
Acid mixture plus Calcium limestone	33	14	33	17	33	16
Potassium Sulfate versus Potassium Chloride						
K_2SO_4 Unlimed ½ plot	21	10	31	5	26	8
KCl Unlimed ½ plot	34	15	—	—	34	15
K_2SO_4 Limed ½ plot	25	6	32	7	29	7
KCl Limed ½ plot	31	19	38	11	34	16

[1] The A and B seed came from the same lot of seed potatoes. The A seed consisted of tubers which did not show SEB and the B seed consisted of tubers with SEB. All tubers with net necrosis were discarded.
[2] SEB = Stem-end browning.
[3] NN = Net necrosis.

TABLE 3—Concluded

Treatment	A — Clear flesh seed		B — Stem-end browning seed		Average	
	% SEB	% NN	% SEB	% NN	% SEB	% NN
Check Plots						
2000 lbs. of 4-8-8	31	19	39	16	35	18
2000 lbs. of 4-8-8	40	16	36	16	38	16
Effect of Organic Matter						
A, Crimson cut and removed	35	13	34	15	34	14
B, Crimson plowed under	31	19	39	16	35	18
C, Crimson from plots A & C plowed under	42	19	40	14	41	16
D, Crimson crop plus 6 tons of straw per acre plowed under	38	24	40	18	39	21
E, Crimson crop plus 20 tons manure per acre plowed under	23	31	30	30	26	30
Sources of Nitrogen						
Nitrate of soda	42	10	42	11	42	11
Sulfate of ammonia	28	11	35	21	32	16
Sulfate of ammonia equivalent acidity neutralized with calcium limestone	34	10	34	16	34	13
½ Nitrate, ½ Sulfate of ammonia	36	14	35	15	35	14
Delayed nitrogen	30	11	30	10	30	11
Broadcast Application of P_2O_5 and K_2O						
A 4-8-8 (½-½-0) 2000 lbs. / A.	31	22	30	12	30	17
B 4-8-8 + Ca hydrate (72% CaO)	39	13	45	9	42	11
C 4-8-8 + Mg from Sea Water magnesia	47	14	46	13	46	13
D 4-8-8 plus Dol.L.S. 2000 lbs. per acre (D.L.S. containing 670 lbs. CaO) (B received), and 380 lbs. MgO (C received)	44	19	44	18	44	18
Continuous Cropping to Potatoes[4]						
East Half of Plot	36	16	46	15	39	16
" " " "	50	18	39	35	46	24
" " " "	44	13	55	15	48	14
" " " "	48	20	54	20	50	20
" " " "	41	18	52	15	45	17
West Half of Plot	37	21	29	24	34	22
" " " "	52	21	53	21	53	21
" " " "	46	29	57	25	50	28
" " " "	44	25	46	24	45	24
" " " "	48	23	48	23	48	23

[4] East half of plots received potassium sulfate as a source of potash and the west half received potash from potassium chloride.

TABLE 4

Stem-End Browning and Net Necrosis Readings on Potato Samples from Permanent Plots, 1942
Samples stored at 36° F.

Treatment	A – Clear flesh seed[1]		B – Stem-end browning seed[1]		Average	
	% SEB[2]	% NN[3]	% SEB	% NN	% SEB	% NN
Rate of Application						
No fertilizer						
1500 lbs.	4	9	4	6	4	7
2000 lbs.	1	8	3	9	2	8
2500 lbs.	6	16	5	11	6	13
3000 lbs.	4	9	5	8	4	8
Fertilizer Ratios						
0-8-8	2	6			2	6
2-8-8	5	4	2	2	4	3
4-8-8	1	8	3	9	2	8
6-8-8	4	17	2	8	3	13
4-0-8	1	2			1	2
4-4-8	8	2	4	10	6	6
4-8-8	1	8	3	9	2	8
4-12-8	2	14	3	6	3	10
4-8-0	4	10	1	4	3	8
4-8-4	1	8	3	9	2	8
4-8-10	4	10	4	7	4	9
4 8-12	7	8	6	8	7	8
Sources of Nitrogen						
Nitrate of soda	5	11	6	9	6	10
Sulfate of ammonia	2	4	2	3	2	4
Urea	1	4	—	8	1	6
Fish meal	4	6	2	12	4	6
Cyanamid	2	8			2	8
½ NO_3–½ NH_3	3	13	0.4	3	2	8
⅜ NO_3–⅜ NH_3–¼ ORG.	1	8	3	9	2	8
¼ NO_3–¼ NH_3–½ ORG.	4	9	4	11	4	10
Chemically Pure Salts						
80 lbs. of N, 160 lbs. of P_2O_5, and 160 lbs. of K_2O from chemically pure salts (mono-ammonium phosphate, potassium nitrate, and urea)	1	4	4	3	3	3
	3	5	1	1	2	3
	—	—	4	4	4	4
	1	1	3	0.5	2	1
	4	2			4	2
	0.4	1			0.4	1
	3	4			3	4
Acid versus Neutral Fertilizers						
Acid mixtures	3	9	4	4	3	6
Acid mixture plus Kieserite	4	9	7	7	5	8
Acid mixture plus Dolomite	5	18	4	12	4	15
Acid mixture plus Calcium limestone	4	9	3	8	3	8
Potassium Sulfate versus Potassium Chloride						
K_2SO_4 Unlimed ½ plot	4	6			4	6
KCl Unlimed ½ plot	1	6			1	6
K_2SO_4 Limed ½ plot	2	4			2	4
KCl Limed ½ plot	2	10			2	10

[1] The A and B seed came from the same lot of seed potatoes. The A seed consisted of tubers which did not show SEB and the B seed consisted of tubers with SEB. All tubers with net necrosis were discarded.
[2] SEB = Stem-end browning.
[3] NN = Net necrosis.

TABLE 5

Amount of Stem-End Browning and Net Necrosis in Potatoes Harvested at Different Dates

Storage Temperature	Date of harvest				
	9/2/42	9/11/42	9/22/42	10/5/42	10/15/42
	Per cent Stem-end Browning[1]				
36° F.	10.9	9.3	6.5	6.1	5.0
Soil temperature[2]	32.3	27.5	16.9	15.0	12.8
50° F.	48.9	35.6	21.0	15.5	11.4
	Per cent Net Necrosis[1]				
36° F.	11.8	11.7	6.1	6.1	6.6
Soil temperature	21.9	14.8	6.7	15 8	11.6
50° F.	16.3	12.9	11.5	14.5	8.7

[1] The SFB and NN readings were based on samples consisting of one boxful (approximately 200 tubers) from each of three places in one field of potatoes. Thus three boxes of tubers from each harvest were stored at each of the three temperatures.
[2] The temperature of this bin was varied with the temperature of the soil. Thus the temperature varied from about 65° F. in early September down to 36° F. in November. After the soil temperature reached 36° F. the bin was maintained at 36° F. for the remainder of the storage period.

TABLE 6

Stem-End Browning and Net Necrosis in Potatoes Grown with Fertilizers Having Different Sources of Potash, 1942

Potash source in 5-8-12 2000 lbs. per acre	Per cent SEB[1] and NN[2]					
	Farm No. 1		Farm No. 2		Average	
	SEB	NN	SEB	NN	SEB	NN
Muriate of potash	24	20	66	14	48	16
½ KCl and ½ K_2SO_4	25	10	65	12	52	11
Sulfate of potash	25	10	65	8	48	9
Potassium metaphosphate Potassium nitrate	23	9	62	5	46	7

Note: Each sample consisted of three boxes of potatoes (500-700 tubers). The samples were stored at 50° F. from date of harvest until examined about March 1, 1943.
[1] SEB = Stem-end browning.
[2] NN = Net necrosis.

TABLE 7

Potato Stem-End Browning Fertilizer Test, 1942

Location: Caribou — Killing freeze: Sept. 26, 1942
Planted: June 8, 1942
Seed Source: Green Mountains with Stem-end browning

1250 lbs. per acre	Pounds per 24-ft. of row				Acre yield		NN[1] [3]	SEB[2] [3]
	Section I	Section II	Section III	Section IV	Bu.	Bbl.	%	%
8-16-20[4]	43.0	37.6	35.9	43.0	402	146	10.8	47.6
Plus barium chloride 20 lbs. per acre	36.0	42.1	38.8	38.7	392	143	13.3	46.0
Plus bismuth chloride 20 lbs. per acre	44.0	42.7	34.5	38.7	403	147	10.0	44.3
Plus cadmium chloride 20 lbs. per acre	39.5	30.7	44.0	41.2	392	143	10.2	27.9
Plus lithium chloride 20 lbs. per acre	48.0	39.1	43.7	39.8	430	156	10.2	45.2
Plus strontium chloride	48.0	50.7	40.5	42.8	451	167	6.9	45.3
Minimum difference for significance					66	24		

[1] NN = Net necrosis.
[2] SEB = Stem-end browning.
[3] Average of four plots. Total number of tubers for each treatment between 566-640.
[4] 8-16-20 fertilizer was purchased in 1942.
Fertilizer plus compounds were mixed prior to spreading by hand. Seed hand planted, 12 inches apart.

TABLE 8

Leafroll in Early Harvested and Late Harvested Potatoes from Foundation Plots in 1942

Variety	Number of		Average per cent of leafroll	
	Plots early harvested	Plots late harvested	Plots early harvested	Plots late harvested
Chippewa	6	2	.35	7.1
Sebago	8	12	.07	.77
Katahdin	8	7	.18	.32
Green Mountain	7	14	.1	1.2
Irish Cobbler	6	7	.23	1.07
Houma	3	4	0.0	.9

TABLE 9

Summary of the Number of Lots of Seed Tested in Florida in 1941 and in 1942 by Varieties

Variety	Number of lots tested		Number lots not recommended for seed stock[1]		Number lots recommended for growing			
					Table stock[2]		Certified seed stock[3]	
	1941	1942	1941	1942	1941	1942	1941	1942
Bliss	7	4	2	2	3	2	2	0
Chippewa	33	57	7	29	16	15	10	13
Earlaine #2	1	1	0	0	0	1	1	0
Green Mountain	129	94	20	12	60	35	49	47
Houma	31	10	0	0	2	3	29	7
Irish Cobbler	77	89	11	19	30	42	36	28
Katahdin	71	83	4	1	7	15	60	67
Pontiac	1	1	0	0	0	0	1	1
Russet	0	2	0	0	0	2	0	0
Sebago	44	55	2	2	13	15	29	38
Sequoia	0	6	0	0	0	4	0	2
Warba	2	1	0	0	2	1	0	0

[1] More than 10 per cent leafroll.
[2] Not more than 10 per cent leafroll.
[3] Disease not exceeding 2 per cent in leafroll and 3 per cent in mosaic.

TABLE 10

Summary of Acreage Represented in Florida Test 1941 and 1942 by Varieties

Variety	Acreage represented		Acreage not recommended[1]		Acreage for table stock seed[2]		Acreage for certified seed[3]	
	1941	1942	1941	1942	1941	1942	1941	1942
Bliss	78.0	43.0	8.5	11.0	51.5	32.0	18.0	0
Chippewa	484.8	796.5	191.0	530.4	209.3	169.6	84.5	96.5
Earlaine #2	4.4	12.0	0	0	0	12.0	4.4	0
Green Mountain	2008.6	1578.0	358.9	163.5	932.0	851.5	717.7	563.0
Houma	136.0	68.5	0	0	13.5	38.5	122.5	30.0
Irish Cobbler	1260.9	1510.8	116.6	382.5	592.5	840.5	551.8	287.8
Katahdin	763.5	1009.4	0	28.0	132.5	137.7	631.0	843.7
Pontiac	1.0	9.0	0	8.0	0	0	1.0	1.0
Russet	0	16.0	0	0	0	16.0	0	0
Sebago	274.3	513.1	3.3	32.0	100.0	183.5	171.0	297.6
Sequoia	0	22.5	0	0	0	20.0	0	2.5
Warba	12.0	6.0	0	0	12.0	6.0	0	0
Total	5023.5	5584.8	678.3	1155.4	2043.3	2307.3	2301.9	2122.1

[1] More than 10 per cent leafroll.
[2] Not more than 10 per cent leafroll.
[3] Not more than 2 per cent leafroll and 3 per cent mosaic.

TABLE 11

Summary of Acreage by Varieties in the 1941-1942 Florida Tests Expressed on a Percentage Basis

Variety	Acreage entered		Per cent of acreage not recommended for seed[1]		Per cent acreage recommended for Table stock seed[2]		Per cent acreage recommended for Certified seed[3]	
	1941	1942	1941	1942	1941	1942	1941	1942
Bliss	78.0	43.0	11	26	66	74	23	None
Chippewa	484.8	796.5	40	67	43	21	17	12
Earlaine #2	4.4	12.0	None	None	None	All	All	None
Green Mountain	2008.6	1578.0	18	10	46	54	36	36
Houma	136.0	68.5	None	None	10	56	90	44
Irish Cobbler	1260.9	1510.8	9	25	47	56	44	19
Katahdin	763.5	1009.4	None	3	17	14	83	83
Pontiac	1.0	9.0	None	None	None	None	All	All
Russet	0	16.0	None	None	None	All	None	None
Sebago	274.3	513.1	1	7	37	35	62	58
Sequoia	0	22.5	None	None	None	89	None	11
Warba	12.0	6.0	None	None	All	All	None	None

[1] More than 10 per cent leafroll.
[2] Not more than 10 per cent leafroll.
[3] Not more than 2 per cent leafroll and 3 per cent mosaic.

TABLE 12

The Ratio of Net Necrosis to Leafroll in Green Mountains for the Seasons 1940 and 1941

Year	Net necrosis	Leafroll	Ratio of net necrosis to leafroll	
	per cent	per cent	Absolute	As per cent
1940	4.11	18.54	1:4.51	22.17
1941	6.39	18.02	1:2.82	35.46

TABLE 13

Field Development of Late Blight at Different Distances from Infected Refuse Piles in 1942, as Expressed in Percentage of Hills Diseased Early in July

Field number	100 ft. or less	100-200 ft.	300-400 ft.	500-600 ft.	Over 600 ft.
	per cent	per cent	per cent	per cent	per cent
1	23	5	1	2	0
2	40	8	0	0	0
3	56	7	0	0	0
4	19	3	0	0.5	0
5	83	15	4	Trace	0

TABLE 14

Yield Comparison of Green Mountain Plots Sprayed with Bordeaux Mixture Prepared with Different Formulae and Applied with Tractor-Power Machine

Formula[1]	Total copper sulphate used for season	Yield per acre[2 3]	
	Pounds	Barrels	Bushels
10-5-100	126.0	175	483
8-4-100	100.8	177	489
6-3-100	75.6	179	493
4-2-100	50.4	177	487
Unsprayed control	—	97	266

[1] Plots received nine applications of approximately 140 gallons per acre per application.
[2] Yields based on mean of 16 one-row replicated plots each 155 feet long.
[3] Significance at the 5 per cent level is 16.86 barrels or 46.54 bushels.

TABLE 15

Yield Comparison of Green Mountain Plots Sprayed with Bordeaux Mixture Prepared with Different Formulae and Applied with a Wheel-Traction Machine

Formula[1]	Total copper sulphate used for season	Yield per acre[2 3]		Protective coefficient[4]
	Pounds	Barrels	Bushels	
10-5-100	81.0	160	440	1.00
8-4-100	64.8	149	410	.90
6-3-100	48.6	145	401	.83
4-2-100	32.4	140	385	.62
Unsprayed control	None	114	314	—

[1] Plots receiving nine applications of approximately 90 gallons per acre per application.
[2] Yields based on 12 one-row replication each 150 feet long.
[3] Significance at the 5 per cent level is 13.19 barrels or 36.06 bushels.
[4] Equal to infective index of standard Bordeaux mixture (which is 1) divided by infective index of treatment compared using the late blight disease. (Adopted from Horsfall, James G. and John W. Heuberger. Measuring magnitude of a defoliation disease of tomatoes. Phytopath. 32:226-232. 1942.)

TABLE 16

Summary Yields—Barrels per Acre for Green Mountains Sprayed with Different Copper Fungicides at Four Different Concentrations[1]

Fungicide	Formulae used in terms of Bordeaux mixture			
	4-2-100	6-3-100	8-4-100	10-5-100
	Barrels per acre	Barrels per acre	Barrels per acre	Barrels per acre
Basi-cop[2]	120	115	152	175
Spray-cop[3]	125	129	152	191
Tennessee tri-basic copper sulphate[2]	123	112	147	185
Cuprocide[4]	114	104	145	183
Copper Hydro Arsenate[5] [6]	121	100	139	172
Bordeaux	127	124	156	191

[1] This experiment was conducted on four separate fields and therefore the yields for the different concentrations cannot be compared directly with each other.
[2] Said to contain 52 per cent metallic copper.
[3] Said to contain 34 per cent metallic copper.
[4] Said to contain 83 per cent metallic copper.
[5] Said to contain approximately 17.97 per cent metallic copper and 10.99 per cent arsenic.
[6] Applied at concentrations equal to ½ that of other fungicides.

TABLE 17

Yield Comparison of Spergon and Bordeaux for the Green Mountain Variety

Fungicide	Formula used	Yield per acre	
		Barrels	Bushels
Spergon	4-100	133	365
"	2-100	122	335
Bordeaux	10-5-100	156	428

TABLE 18

The Effect on Yield of Spraying Green Mountain Potatoes with Copper Fungicides and with Combinations of These Fungicides with Rotenone

Fungicide	Formula	Yield per acre		Increase from applying rotenone[1]
		Without rotenone	With rotenone	
		Barrels	Barrels	Barrels
Cuprocide[2]	1½-100	157	173	16
Bordeaux Mixture	10-5-100	168	175	7
Copper Hydro Arsenate[3]	5-100	149	165	16

[1] Significance at 5 per cent level is 14.55 barrels.
[2] Said to contain 83 per cent metallic copper.
[3] Said to contain approximately 17.97 per cent metallic copper and 10.59 per cent arsenic.

TABLE 19

Total Solids and Starch of Three Varieties of Potatoes with Variation in Source of K_2O in Fertilizer

Variety	K_2O treatment[1]	Total solids	Starch	Cooking test mealiness[2]	Total solids	Starch	Cooking test mealiness
		%	%		%	%	
			Farm	No. 1		Farm	No. 2
Chippewa 1	KCl (60% K_2O)	19	12.4	1	15.4	10.0	1+
2	½ KCl, ½ K_2SO_4	20	12.5	1+	15.7	11.3	2
3	K_2SO_4 (48.5% K_2O)	21.5	13.2	2	16.1	11.7	2
4	½ KPO_3 (meta), ½ KNO_3	21	13.1	2 (6.3)	17.3	11.2	2+ (7.6)
Mountain 1	KCl (60% K_2O)	22.9	15.4	4	17.2	13.3	3+
2	½ KCl, ½ K_2SO_4	24.9	16.4	4	23.0	13.7	3+
3	K_2SO_4 (48.5% K_2O)	25.3	16.2	4–	23.1	13.9	4–
4	½ KPO_3 (meta), ½ KNO_3	24.8	15.3	4 (15.7)	22.5	13.7	3+ (13.7)
Sebago 1	KCl (60% K_2O)	20.6	13.0	1	20.3	12.4	2–
2	½ KCl, ½ K_2SO_4	21.4	13.8	2–	21.1	12.5	2–
3	K_2SO_4 (48.5% K_2O)	22.8	15.3	2–	21.4	12.5	2–
4	½ KPO_3 (meta), ½ KNO_3	22.0	15.1	3 (8.1)	21.5	13.3	3 (8.1)

[1] Treatments 1 2, and 3—All P_2O_5 from ammo phos (11.4-47.6); balance of nitrogen—21.7% from sulfate of ammonia to total 60% from ammonia, 25% from nitrate of soda, 15% from fish meal; potash from respective sources—1—KCl (60% K_2O) 3—K_2SO_4—(48.5% K_2O).

Treatment 4—All P_2O_5 from potassium metaphosphate ($K_4(PO_3)_4.2H_2O$ (51.6% P_2O_5—35% K_2O) which furnished 45.2% of the K_2O. Balance of K_2O was supplied by potassium nitrate (13-41) which furnished 42% of the nitrogen. Balance of the nitrogen or 58% was supplied by uramon.

All treatments had magnesium supplied by Dolomitic limestone.

[2] 1—non mealy, 2—slightly mealy, 3—moderately mealy, 4—mealy. (Cooking tests by Dr. Sweetman.) Fertilizer 2,000 pounds 5-8-12.

Farm No. 1—land, timothy sod plowed about ten days before planting on May 30, 1942. When harvested, Chippewa vines nearly dead, Mountain vines not quite as green as Sebago, Sebago vines green when killing freeze occurred.

Farm No. 2—land in potatoes for third consecutive year, planted May 29, 1942. Vines, especially Mountains, were still green when killing freeze occurred on September 26.

TABLE 20

Yield Test and Starch Content of Potato Varieties Grown at Aroostook Farm by Robert V. Akeley 1941 and 1942
Randomized with five replicates

Variety	Starch average (1941)	Total yield bushels per acre (1941)	Starch content (1942)	Total yield bushels per acre (1942)	Number potatoes to 5 kilos (1942)
Parnasia	16.0	112	—	—	—
Metador	17.3	267	16.4	167	43
Popular	18.6	220	17.9	125	43
Record	18.9	327	18.5	243	41
Fruhegold	14.1	332	14.7	201	57
Ostbote	20.4	385	17.7	203	64
Voran	18.0	385	16.4	231	45
To be identified	18.6	365	—	193	53
Mittlefruhe	17.5	372	16.0	236	55
Ackersegen	17.0	438	17.6	243	57
Green Mountains	18.5	460	17.7	256	35
Katahdin	15.4	385	13.9	201	43
Houma	15.4	460	—	—	—
Sebago	—	—	16.7	232	33
Irish Cobbler	—	—	15.1	232	33
Iduna	—	—	16.5	149	53
Starkergis	—	—	18.5	192	55
Triumf	—	—	17.4	82	53
Edrgold	—	—	17.1	225	39
Prisca	—	—	17.3	231	46
Ergenheimer	—	—	17.2	136	48
Ultimus	—	—	17.5	175	51